HOLETOWN NOISE CHARACTERIZATION STUDY

PROJECT REPORT

Environmental Protection Department

ENVIRONMENTAL PROTECTION DEPARTMENT

Date Created: 30 July, 2019

Date of last revision: - 12 December, 2022

Version Number: 2.0

	Name /Qualification	Signature	Date
Prepared By	L. Chapman BSc Chemical & Process Engineering, MSc Project Management, AMIOA		19th November 2019
Reviewed By	Lisa Senhouse, BSc. Civil Engineering, MSc. Integrated Environmental Management		28th March 2020
Approved By	Anthony Headley, BSc Chemical Engineering. M.Sc. Environmental Engineering P.Eng		7th August 2020

Acknowledgements

The Environmental Protection Department acknowledges the contribution made by its staff to the successful completion of the Holetown Noise Characterization Study and thanks the following agencies or businesses for their role in the study. These agencies or businesses are:

Royal Bank of Canada

Grendon Holdings Inc.

The Beach House

Ministry of Transport and Works

The Royal Barbados Police Force

Contents

List of Figures

1.0 Glossary

- Decibel (dB): a unit of sound level
- L_{A10}: The sound level that was exceeded during 10% of the measuring time in dB(A).
- L_{A90}: The sound level that was exceeded during 90% of the measuring time in dB(A).
- L_{Aeq}: The continuous equivalent sound level which is the single sound pressure level (SPL) that, if constant over the stated measurement period, would contain the same sound energy as the actual monitored fluctuating sound level over the measurement period in dB(A).
- L_{Amax}: The maximum sound pressure level (SPL) value measured during the duration of monitoring in dB(A).
- L_{Amin}: The minimum sound pressure level (SPL) value measured during the duration of monitoring in dB(A).
- Sound pressure level (SPL): A logarithmic measure of the effective sound pressure of a sound relative to a reference value. It is measured in decibels (dB) above a standard reference level.
- WHO: Acronym for World Health Organization.

2.0 Executive Summary

Holetown, previously called Jamestown, was the site at which the first settlers of Barbados landed. The site was called Jamestown in honour of the then King of England. Within Holetown is a central core or mixed use corridor where typical commercial facilities are located such as banking, shopping, library, post office, restaurants, doctors' offices, pharmacies, gas station, magistrate court and a police station. Within wider Holetown there are hotels/guest accommodation, residences, schools and recreational parks/ green spaces. At the time of writing Holetown could be characterized as a relatively busy town/ strip corridor surrounded by upscale tourist accommodation. Holetown is approximately 1.35km^2 with a central core of about 0.23km^2 [1]. Traffic counts provided by the Ministry of Transport and Works in 2018 indicated that 10095 to 14828 vehicles passed through Holetown's central core daily. The housing stock in and around Holetown ranged from chattel houses to multi storey concrete houses.

The Environmental Protection Department (EPD) designed and implemented this Holetown Noise Characterization Study in order to gather baseline data and characterize the sound levels which persons were exposed to while in/near Holetown. Currently there is limited sound level data on Barbados with most of the focus being on sound levels due to complaints and not the general noise climate. Similar studies had been done for Bridgetown (2012/2013), Oistins (2017) and Speightstown (2018).

The project involved surveillance of the activities carried out in the area, monitoring of sound levels, traffic counts, weather data collection, analysis of the data, writing of a final report and close out of project. The noise descriptors collected were on the A-scale, fast response: L_{A10}, L_{A90}, L_{Aeq}, L_{Amax}. The monitoring locations used were Royal Bank of Canada, Grendon Holding (Trents) and The Beach House.

Some of the important findings and conclusions of the study were:

- In general, the noise levels persons were exposed to while in Holetown, at the sites

[1]Estimated using the National Physical Development Plan (Amended 2003) and Google Earth Pro

monitored, were within World Health Organization (WHO) guidelines for community noise for industrial, commercial shopping and traffic areas. No suitable, secure residential site was identified but given the (L_{Aeq}) for the three sites ranged from 60 to 70dBA and the L_{Amax} varied from 89 to 104dBA there is the possibility that residences on the fringes of the mixed use area may experience sound levels above the L_{Aeq} of 55dBA (day) and 45dBA (night) recommended by WHO for residential areas.

- Traffic noise was the main observed activity near the monitoring sites followed by people (talking, liming).
- The relationship between L_{Aeq} and traffic counts was investigated using Spearman's rank order correlation. At all sites there was a strong, positive correlation between the two variables. It should be noted that the above results only indicated if high traffic counts and high sound levels (or vice versa) tend to occur together. Whether this link was a direct link or indirect link was not investigated. For example, increased traffic counts could mean an increase in other sources of noise e.g. person related sounds and general business activity which could instead be the direct factor(s) for increased sound levels.
- The L_{Aeq} values recorded on Sundays were quieter than any other day of the week at all the sites. This is in keeping with the historical trend for Sundays.

The following recommendations and critical assessment are made:

- *There should be an increased focus on gathering sound level data across Barbados as well as educating the public on* the effects of noise.
- *In order to maintain the sound levels in Holetown at acceptable levels, future projects or programmes planned should take sound levels into consideration.* Not only should existing receptors be considered but also the possible locations of future surrounding receptors. While it is difficult to give exact suggestions as it depends on the noise source, proximity of sensitive receptors, time of day that the high sound levels occur etc. some possible general noise management options are setting a minimum sound transmission class of building materials, restricting the number of dwellings and density in some areas, noise

barriers/buildings, setting buffer areas, enforced cut off times for loud activities, setting up of permanent monitoring stations.

- *Continuous control/ management of the traffic related sound levels within the town*: As traffic levels appear to have an impact on the sound levels in Holetown efforts should be made to control traffic related sounds in the area. Additionally, any new large scale development in/ near the town can impact traffic counts and consequently sound levels. Issues such as the design and conditon of the road network, parking space availability, location of mass transit routes and other issues which can increase/decrease traffic volumes or congestion. Other areas that can help control or manage road traffic noise were paving roads with noise dampening asphalt, maintaining the road surface, encouraging the use of quieter vehicles (e.g. with tax deductions, reduce importation taxes), discouraging the unnecessary use of vehicle horns, use of electric powered buses.
- *Similar baseline data should be collected for other areas in Barbados.*
- *Depending on the purpose of the study/investigation, only areas where short-term sampling during the busiest/noisiest periods exceeds desired limits may require further long-term monitoring*. This could be part of the criteria for site selection, as it would increase the efficiency with which resources are used.
- *Further training and resources should be obtained for capacity building of the Environmental Protection Department and by extension Barbados.*

3.0 Introduction

Holetown, previously called Jamestown, was the site at which the first settlers of Barbados landed. The site was called Jamestown in honour of the then King of England. According to the National Physical Development Plan (Amended 2003) Holetown runs from Bennetts Road in the south, northwards along the 40m contour line, and westward along Porters Road to the sea near Colony Club (See Figure 1) (Government of Barbados, 2003).

Within Holetown is a central core or mixed use corridor where typical commercial facilities are located such as banking, shopping, library, post office, restaurants, doctors' offices, pharmacies, gas station, magistrate court and a police station. Within wider Holetown there are hotels/guest accommodation, residences, schools and recreational parks/ green spaces. At the time of writing Holetown could be characterized as a relatively busy town/ strip corridor that was surrounded by upscale tourist accommodation.

Holetown is approximately 1.35km^2 with a central core of about 0.23km^2 [2]. Traffic counts provided by the Ministry of Transport and Works indicated that 10095 to 14828 vehicles passed through Holetown's central core daily. The housing stock in and around Holetown ranged from chattel houses to multi storey concrete houses.

The Environmental Protection Department (EPD) designed and implemented this Holetown Noise Characterization Study in order to gather baseline data and characterize the sound levels which persons were exposed to while in/near Holetown. Currently there is limited noise data on Barbados with most of the focus being on noise levels due to complaints and not the general noise climate. Similar studies had been done for Bridgetown (2012/2013), Oistins (2017) and Speightstown (2018).

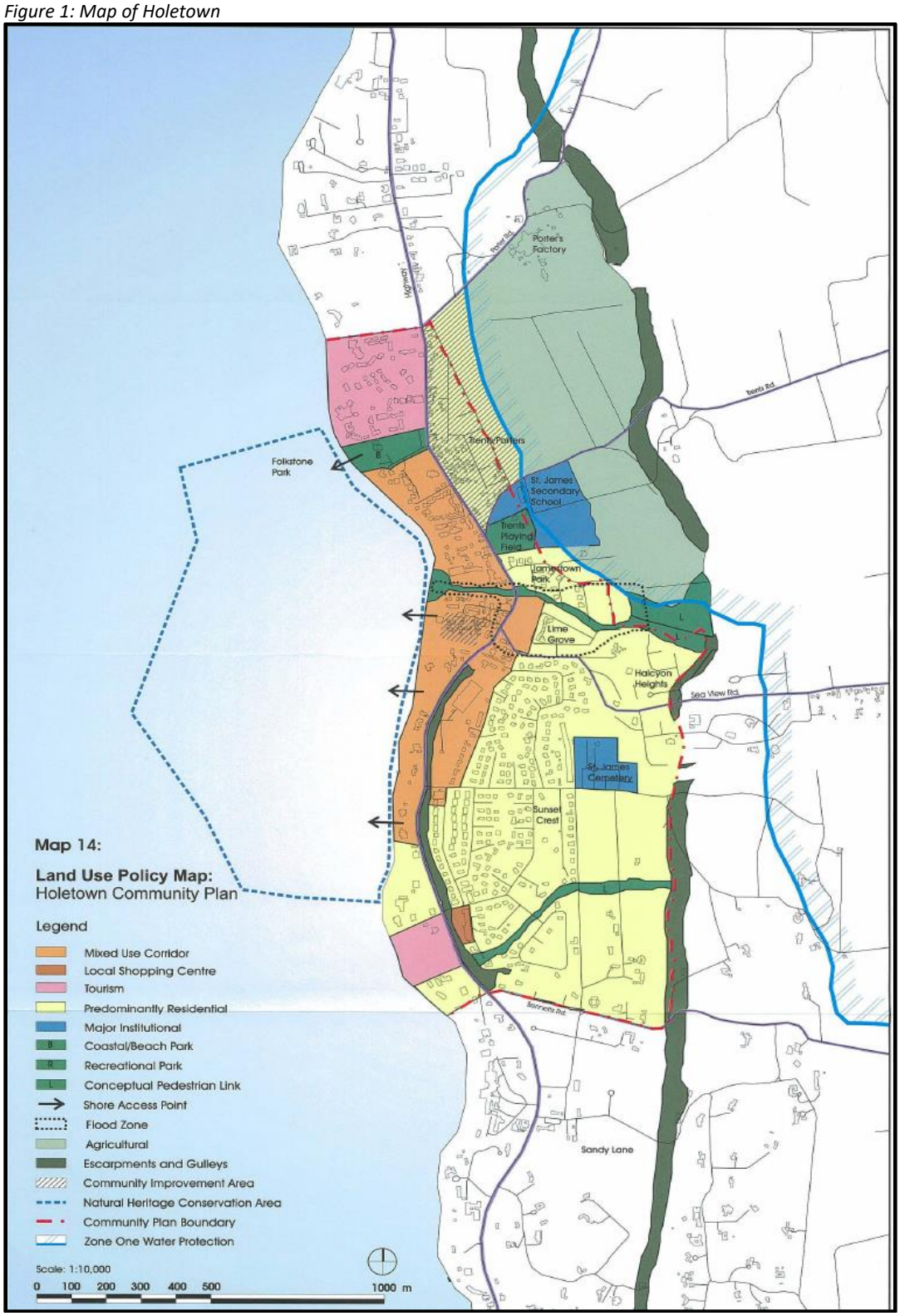
It is true that noise is subjective and often defined as "unwanted sound" (Cowan, 1994) resulting in it being difficult to set noise limits. According to the World Health Organization (WHO) Guidelines for Community Noise, exposure to high noise levels could lead to various health effects including temporary or permanent hearing loss, interference with speech communication, sleep disturbance as well as annoyance. WHO set the noise limits for

[2]Estimated using the National Physical Development Plan (Amended 2003) and Google Earth Pro

commercial areas at L_{Aeq}70dBA over 24hrs and L_{Amax} 110dBA. For residential areas WHO sets limits L_{Aday} and $L_{Aevening}$ at 55dBA during the day and evening (16hrs) and L_{Aeq} 45dBA during the night (8hrs). Further WHO advised that in order to avoid hearing impairment, noise exposures should never exceed 140dB for adults and 120dB for children (World Health Organization:, 1999). Barbados' Cabinet adopted the WHO Guidelines for Community Noise as policy in 2007.

This project focused on Holetown's central core as shown by the orange/peach areas in Figure 1 below, since this area would have the highest people counts and activity levels and should provide the highest ambient sound levels for Holetown as well as the highest number of persons that should be affected. The central core encompassed the commercial entities. The wider Holetown area is outlined by the red dotted line.

Figure 1: Map of Holetown



Source: National Physical Development Plan (Amended 2003) –not to scale

The monitoring locations used were Royal Bank of Canada, Grendon Holdings Inc.(Trents), and The Beach House. The project involved surveillance of the activities carried out in the area, monitoring of sound levels, traffic counts, weather monitoring, analysis of the data, writing of a final report and close out of project. This document was the final report for the project.

Goal and Objectives

The goal of this project was to characterize the sound environment of Holetown's central core.

This goal was broken down into the following research questions:

1. What were the noise descriptors at the monitoring sites during 24hr monitoring? ($L_{Aeq,15min}$, $L_{A10,15min}$, $L_{A90,\ 15min}$, $L_{Amax,\ 15min}$)
2. What were the major sources of noise identified?
3. How did the recorded noise levels compare with WHO guidelines?
4. Were the twenty-four (24hr) sound levels on Sundays statistically different to those recorded on other days of the week?
5. Was there a correlation between the traffic counts and the noise levels recorded?

Scope

The assessment focused on:

- Recording, analysing and reporting the sound levels (A-scale: L_{A10}, L_{A90}, L_{Aeq}, L_{Amax},) at the monitoring sites within Holetown during the period 26th June to 12th September, 2018.

The assessment did **not** focus on:

- Other sections of Holetown that were outside of the core
- Other possible noise descriptors
- Other time periods
- Workplace noise, as it was not under the purview of the Environmental Protection Department
- Indoor noise e.g. inside the receptors house/building

Limitations, Assumptions and Risks

The following limitations, assumptions and risks were inherent to the project:

Assumptions

- The period of monitoring produced data that was representative of typical sound levels in Holetown.

Limitations

- Some activities were dependent on the timeliness of the response from stakeholders. Frequent contact with stakeholders was done to identify problems as early as possible.
- The staff assigned to conduct the project had other substantive tasks and this led to time constraints due to increased workload.
- Any unusual, noisy events or activities occurring near the monitoring site would skew the results. Random visits during the monitoring period to each site were conducted in an effort to identify any such occurrences and make any necessary changes to the monitoring (e.g. monitor on another day).
- Noise readings should not be taken during heavy rain or high winds above 5m/s. Additional contingency days were added to the schedule as rain can prevent monitoring. Wind speeds and humidity were noted.
- The availability of suitable, secure locations with flat roofs was a challenge as typical Barbadian residential homes and most buildings were not built with flat roofs. As a result, 24hr monitoring within a residential area was not conducted as a suitable location was not identified.

Risks

- Insufficient resources to conduct all the activities of the project. This did not occur but had it occurred the scope would have been adjusted appropriately.
- Damage to equipment e.g. lightning or rain, vandalization or malfunction. The equipment was insured and the Royal Barbados Police Force was notified of the project.

If damage occurred the scope of the project would be adjusted and/or the option of sourcing alternative equipment considered.

4.0 Study Area

The three monitoring locations selected for twenty-four hour (24hr) monitoring were Royal Bank of Canada, Grendon Holdings Inc. Trents and The Beach House (See Figure 2). The list of the contact persons and contact information for the sites is in Appendix 3. The description and pictures of the monitoring locations are provided below.

*Figure 2: Aerial Map Showing Monitoring Sites and the Holetown Core Area**

Royal Bank of Canada

The Royal Bank of Canada is a typical financial bank located approximately in the centre of the mixed use corridor along Highway 1. Surrounding this business is a church, gas station, police station, restaurants, supermarkets and a heavily trafficked road. Formally the Physical Development Plan of Barbados (2003) zoned the area as a mixed use corridor. The daily traffic counts on the nearby road, Highway 1, ranged from 10858 to 14828. The GPS coordinates are N 13 11.157, W 59 38.217. Monitoring occurred at this site from 26th June to 1st July, 2018.

The microphone was placed in the corner of a small, uncovered, upper level patio to the front of the property. The patio was 3.5m above ground level and the microphone was 1.5 m above the floor of the patio deck which was accessible by interior stairs and via a manager's office. The nearest reflecting surface (wall of the building) was 1m away from the microphone. Pictures of the building as well as the monitoring equipment on the deck of the building are shown in Figure 3.

Figure 3: Royal Bank of Canada

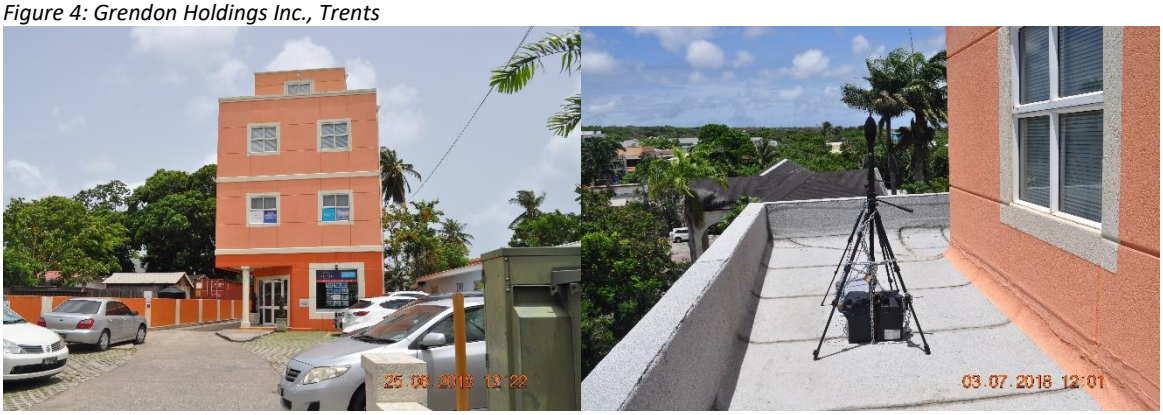
<u>Grendon Holdings Inc , Trents</u>

Grendon Holdings Inc., Trents is an office building along Highway 1 which housed various offices such as a charity and a real estate/property management business. Surrounding this site is Frederick Smith Secondary School, hotels/guest accommodation, a doctor's office, a playing field and a heavily trafficked road. It was located towards the northern end of the mixed use corridor. The traffic counts on the nearby road, Highway 1, ranged from 10095 to 13587. The GPS co-ordinates are N 13 11.313, W59 38.214. Monitoring occurred at the site from 30th June to 5th July, 2018.

The microphone was placed on an uncovered, roof deck to the front of the property. The patio was 10.1m above ground level and the microphone was 1.35 m above the floor of deck/roof which was accessible by interior stairs. The nearest reflecting surface (wall of the

building) was 0.95m away from the microphone. Pictures of the building as well as the monitoring equipment on the deck of the building were shown in Figure 4 .

Figure 4: Grendon Holdings Inc., Trents



The Beach House

The Beach House is a complex that mainly housed a restaurant as well as a barber shop, ice cream parlor and offices. It is located towards the southern end of the Holetown mixed use corridor and is surrounded by a doctor's office/ emergency clinic, restaurants, hotels, residences and a relatively heavily trafficked road. The traffic counts on the nearby road, Highway 1, ranged from 10115 to 13187. The GPS coordinates are N 13 10.989, W 59 38.333. This location was monitored from 8th to 12th September 2018.

The sound level meter was set up on a covered balcony at the front of the building. The microphone was at a height of 4.55 m above the ground level and 1 m away from the nearest reflective surface. Pictures of the building as well as the monitoring equipment are shown in Figure 5.

Figure 5: The Beach House

Summary of monitoring sites

Table 1 below summarizes the characteristics of the monitoring sites used in this study.

Table 1: Summarized characteristics of the monitoring sites

Monitoring site	**Brief description**	**Monitoring period**	**Physical Development Plan of Barbados (2003) Zone**
Royal Bank of Canada GPS coordinates: N 13 11.157 W 59 38.217	A typical financial bank.	26th June – 1st July, 2018	Mixed use corridor
Grendon Holdings Inc. GPS coordinates: N 13 11.313 W59 38.214	An office building.	30th June – 5th July, 2018.	Mixed use corridor
The Beach House GPS coordinates: N 13 10.989 W 59 38.333	Mainly a restaurant with other businesses e.g. a barber shop and ice cream parlour.	8th -12th September 2018.	Mixed use corridor

5.0 Methodology

Monitoring of the general noise climate of Holetown involved unattended monitoring at three receptor sites – Royal Bank of Canada, Grendon Holdings Inc. and The Beach House. In addition to gathering sound level data; meteorological data, traffic counts and activity surveillance data were collected. Bruel & Kjaer 2270 sound level meters (Type 1) and Kestrel 5500 weather meters were used during monitoring. Further details on the equipment used are in Appendix 5.

Project planning included identification of potential locations, preliminary talks with prospective owners, final selection of locations, preparation of lists (checklists, contact lists, schedules), preparation for monitoring, equipment test runs and engaging other stakeholders as required (e.g. Ministry of Transport and Work, Royal Barbados Police Force).

The measurement methodology was based primarily on ISO 1996-2: 2007 Acoustics – Description and measurement of environmental noise. The sites were selected using the following criteria:

- The activity within the mixed corridor was generally homogenous.
- The suitability of a site taking into account factors such as security, accessibility, roof type and roof height.
- Expected degree of stakeholder interest: Noise levels along Highway 1, the main street of Holetown, was anticipated to be of interest to stakeholders as this was where many persons traversed and hence would be impacted by the sound levels in those areas.

The monitoring techniques employed during monitoring were as follows:

- In general the microphone was positioned 3m-11m above the ground, 1.2m-1.5m above the floor level and preferably at least 3.5m away from any reflecting structure other than the ground. It was noted that the optimal microphone position was not achieved at any site.
- A windscreen was used during monitoring.

- The fast weighting was used when taking the measurements.
- It was preferred that the wind speed was between 1 and 5m/s, measured at a height of 3m to 11m above the ground and there was no heavy precipitation.
- In-field calibration was done twice weekly.

The noise descriptors collected were on the A-scale, fast response: L_{A10}, L_{A90}, L_{Aeq}, L_{Amax}, L_{Amin}. An external power supply (12V) was used as the primary power supply with the sound level meter's internal batteries as a backup. Weather proof boxes to allow for outdoor monitoring were used.

Surveillance of the activities occurring at each site was done from June 2018 to July 2019 in order to identify the potential sources of noise. Each day of the week was assessed during the day and at night at each site.

The meteorological data was obtained using a Kestrel 5500 weather meter set up next to the microphone. The meteorological data collected were temperature, wind direction, wind speed, relative humidity, barometric pressure and cloud cover. Other data collected during the project included the type of instrumentation used, start and stop times, GPS location, description of any source(s) of noise and the type of area or zone. The survey form used to record the data was shown in Appendix 4.

At EPD's request, the Ministry of Public Works and Transport placed traffic counters on the roads near to the monitoring sites. The schedule outlining when the traffic counters were deployed at the various locations is shown in Appendix 6. The Royal Barbados Police Force (RBPF) was informed of the project, monitoring locations and their assistance in security surveillance was requested.

The collected data was analyzed using SPSS Statistics and Microsoft Excel. The aerial maps were produced using Google Earth.

6.0 Results

What were the weather conditions during monitoring?

"The data collected indicated that in general the wind speeds varied from 0 to 7.3 m/s, the temperature ranged from 22.6 to 42.6^{o}C, relative humidity from 37.9% to 100% and atmospheric pressure from 995 to 1025mbar during monitoring "

Localized meteorological data was collected using the Kestrel 5500 weather monitor. This was in accordance with ISO-1996: 2007, which required that wind speed, temperature, relative humidity and atmospheric pressure be recorded during monitoring.

The standard indicated that the wind speed should be between 1 to 5 m/s during monitoring. For all sites, the wind speed ranged from 0 to 7.3 m/s with the average daily wind speed ranging from 0.1 to 2.2 m/s. As wind speed cannot be controlled a windscreen was used during monitoring to reduce the effect on the sound level due to the wind. The standard also indicated that there should be no heavy rainfall during monitoring. EPD did not have a rain gauge so reports from persons at the sites were used. If there were reports of a significant volume of rain the data from those days were not used. As a contingency extra monitoring days had been included at each site to accommodate heavy rainfall. Inadvertently the weather meter was not initially logging recording at the RBC monitoring site. Hence weather data for only some days was obtained but sufficient to give an idea of the general weather conditions at the site. The meteorological conditions for each site are in Appendix 1.

What were the noise descriptors for the monitoring sites during 24hr monitoring?

"For the three sites the daily L_{Aeq} ranged from 60 to 70 dBA, the L_{A10} from 62 to 71dBA, the L_{A90} ranged from 43 to 56dBA, the L_{Amin} from 26 to 48dBA, and the L_{Amax} from 89 to 104dBA."

The daily noise descriptors for the three sites used (RBC, Grendon Holdings Inc. and The Beach House) for twenty-four hour (24hr) monitoring were summarized graphically (Figure 6 to Figure 10) and in tabular form below (Table 2). Graphs of the raw fifteen (15) minute data are in

Appendix 2. In general at least five (5) days of the week was monitored at each site. It was desired to monitor for an entire week but due to issues such as batteries dying prematurely or impending bad weather it was not always possible to monitor for the desired time period.

For the three sites the daily L_{Aeq} ranged from 60 to 70 dBA, the L_{A10} from 62 to 71dBA, the LA90 ranged from 43 to 56dBA, the L_{Amin} from 26 to 48dBA, and the L_{Amax} from 89 to 104dBA. It was noted that the sound levels were generally highest at the Royal Bank of Canada and Beach House with lower levels observed at GH Trents Building.

Figure 6: Daily L_{Aeq} values at each site

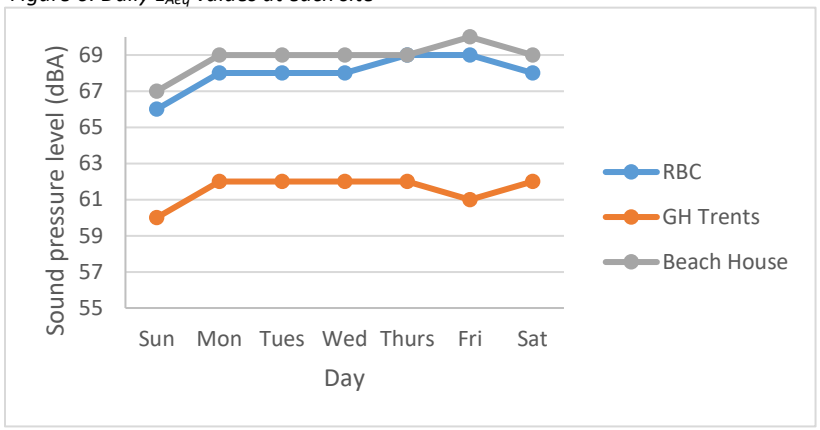


Figure 7: Daily L_{A10} values at each site

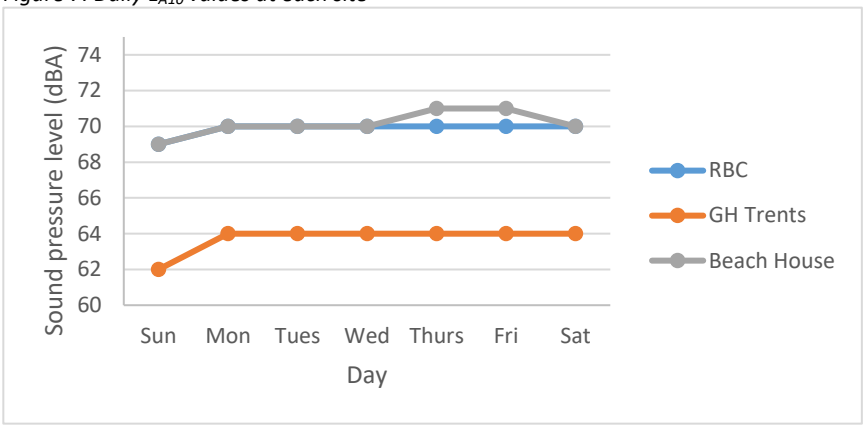


Figure 8:: Daily L_{A90} values at each site

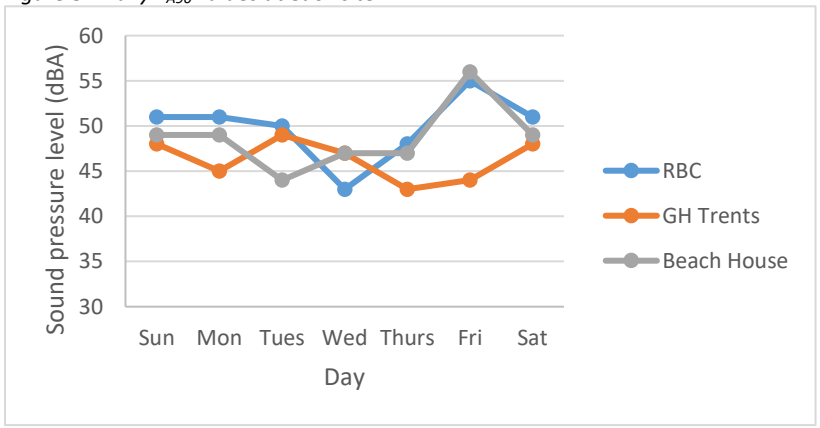


Figure 9:: Daily L_{Amin} values at each site

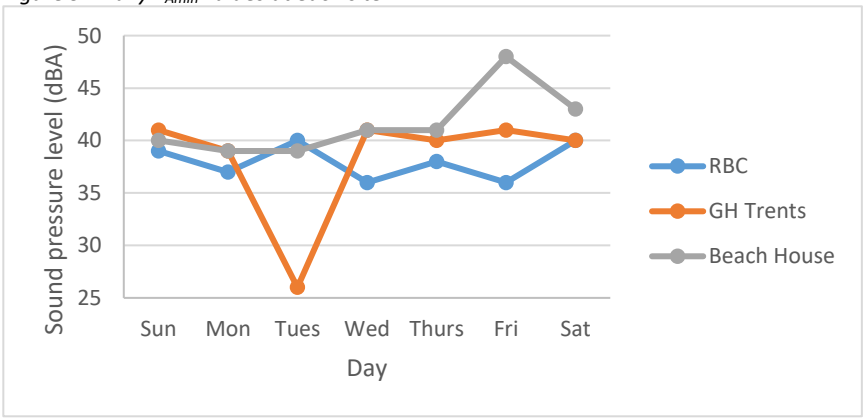


Figure 10:: Daily L_{Amax} values at each site

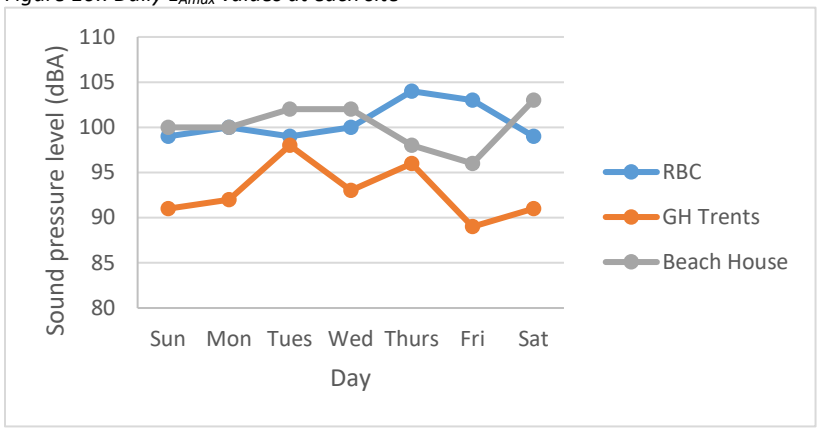


Table 2: Noise descriptor results

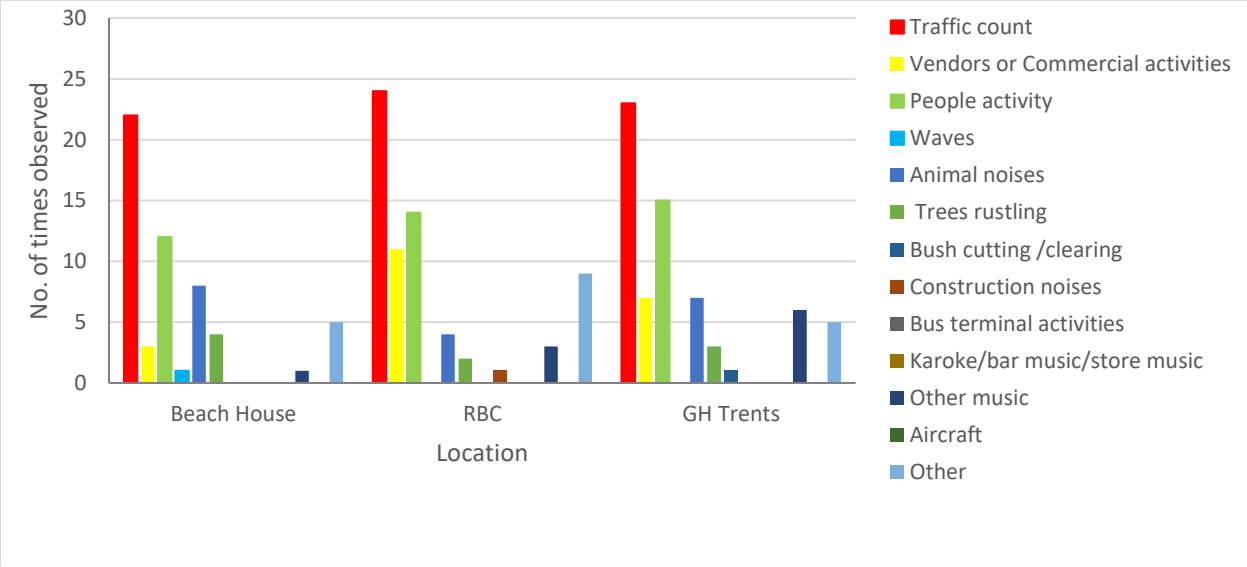
	RBC	GH Trents	Beach House
Sunday	L_{Aeq}: 66	L_{Aeq}: 60	L_{Aeq}: 67
	L_{A10}: 69	L_{A10}: 62	L_{A10}: 69
	L_{A90}: 51	L_{A90}: 48	L_{A90}: 49
	L_{Amin}: 39	L_{Amin}: 41	L_{Amin}: 40
	L_{Amax}: 99	L_{Amax}: 91	L_{Amax}: 100
Monday	L_{Aeq}: 68	L_{Aeq}: 62	L_{Aeq}: 69
	L_{A10}: 70	L_{A10}: 64	L_{A10}: 70
	L_{A90}: 51	L_{A90}: 45	L_{A90}: 49
	L_{Amin}: 37	L_{Amin}: 39	L_{Amin}: 39
	L_{Amax}: 100	L_{Amax}: 92	L_{Amax}: 100
Tuesday	L_{Aeq}: 68	L_{Aeq}: 62	L_{Aeq}: 69
	L_{A10}: 70	L_{A10}: 64	L_{A10}: 70
	L_{A90}: 50	L_{A90}: 49	L_{A90}: 44
	L_{Amin}: 40	L_{Amin}: 26	L_{Amin}: 39
	L_{Amax}: 99	L_{Amax}: 98	L_{Amax}: 102
Wednesday	L_{Aeq}: 68	L_{Aeq}: 62	L_{Aeq}: 69
	L_{A10}: 70	L_{A10}: 64	L_{A10}: 70
	L_{A90}: 43	L_{A90}: 47	L_{A90}: 47
	L_{Amin}: 36	L_{Amin}: 41	L_{Amin}: 41
	L_{Amax}: 100	L_{Amax}: 93	L_{Amax}: 102
Thursday	L_{Aeq}: 69	L_{Aeq}: 62	L_{Aeq}: 69
	L_{A10}: 70	L_{A10}: 64	L_{A10}: 71
	L_{A90}: 48	L_{A90}:43	L_{A90}: 47
	L_{Amin}:38	L_{Amin}: 40	L_{Amin}: 41
	L_{Amax}: 104	L_{Amax}: 96	L_{Amax}: 98
Friday	L_{Aeq}: 69	L_{Aeq}: 61	L_{Aeq}:70
	L_{A10}: 70	L_{A10}: 64	L_{A10}: 71
	L_{A90}: 55	L_{A90}: 44	L_{A90}: 56
	L_{Amin}: 36	L_{Amin}: 41	L_{Amin}: 48
	L_{Amax}: 103	L_{Amax}: 89	L_{Amax}: 96
Saturday	L_{Aeq}: 68	L_{Aeq}: 62	L_{Aeq}: 69
	L_{A10}: 70	L_{A10}: 64	L_{A10}: 70
	L_{A90}: 51	L_{A90}: 48	L_{A90}: 49
	L_{Amin}: 40	L_{Amin}: 40	L_{Amin}: 43
	L_{Amax}: 99	L_{Amax}: 91	L_{Amax}: 103

What were the major sources of noise identified?

"Traffic was the most frequent source of noise identified followed by people (e.g. talking, liming)"

The activities observed during activity surveillance conducted June 2018 to July 2019 at the monitoring sites are shown in Figure 11 below. The types of activities observed as well as the frequency with which they were observed are shown. The sources of noise observed included traffic, sea waves, people related activities such as talking or playing, animal noises and music. As expected, the most frequent sources of noise observed were traffic and people related noises. Sources that were observed infrequently or at relatively few sites were placed in the "Other" category for example sirens.

Figure 11: Activities observed at each location



Row Labels	Traffic count	Vendors or Commercial activities	People activity	Waves	Animal noises	Trees rustling	Bush cutting /clearing	Construction noises	Bus terminal activities	Karoke/bar music/store music	Other music	Aircraft	Other
Beach House	22	3	12	1	8	4					1		5
RBC	24	11	14		4	2		1			3		9
GH Trents	23	7	15		7	3	1				6		5

How did the recorded noise levels compare with WHO guidelines?

"The sound levels at all the sites monitored were within the WHO guidelines values for commercial areas."

The World Health Organization's guideline value for industrial, commercial shopping and traffic areas; indoors and outdoors, was an L_{Aeq} of 70dB with a L_{Amax} of 110dB over a 24hr period. The $L_{Aeq,24hr}$ varied from 60 to 70dBA and the L_{Amax} varied from 89 to 104dBA. Therefore all the areas monitored were within the WHO guidelines for industrial, commercial shopping and traffic areas (See Table 3). The areas of Holetown monitored were commercial. It was desired to set up a monitor within the residential area within wider Holetown but finding a suitable secure house proved difficult.

Table 3: Range of 24hr L_{Aeq} and L_{Amax} values at the monitoring sites

	RBC	GH Trents	Beach House
L_{Aeq} /dBA	66-69	60-62	67-70
L_{Amax} /dBA	99-104	89-98	96-103

Were the 24hr sound levels (L_{Aeq}) on Sundays statistically different to those recorded on other days of the week?

"The L_{Aeq} values recorded on Sundays were statistically different to the other days of the week at all three sites with Sundays being quieter."

For the analysis the 24hr Sunday data for each site was compared to each weekday's data for that particular site. The data was first tested for normality using histograms, Kurtosis and Skewness and the Kolmogorov–Smirnov (KS) statistic. Based on the tests conducted, in general the data was not found to be normally distributed and the non-parametric Wilcoxon Signed Rank Test was used for the comparison analysis. If the difference between the sound levels (Sunday vs. weekday) was statistically significant the significance level (Asymp. Sig. (2-tailed)) would be below 0.05. Culturally or historically Sundays were quieter than other week days in Barbados and this trend was noted at all the sites in Holetown.

The Wilcoxon Signed Rank Test showed that at the Royal Bank of Canada location Sunday's sound levels were statistically different to those during the week with Sunday being generally quieter (See Table 4). A graph showing the L_{Aeq} over the week is also provided in Figure 12.

Table 4: Results of Wilcoxon Signed Rank Test for Royal Bank of Canada comparing Sunday's L_{Aeq} values with other weekday L_{Aeq} values

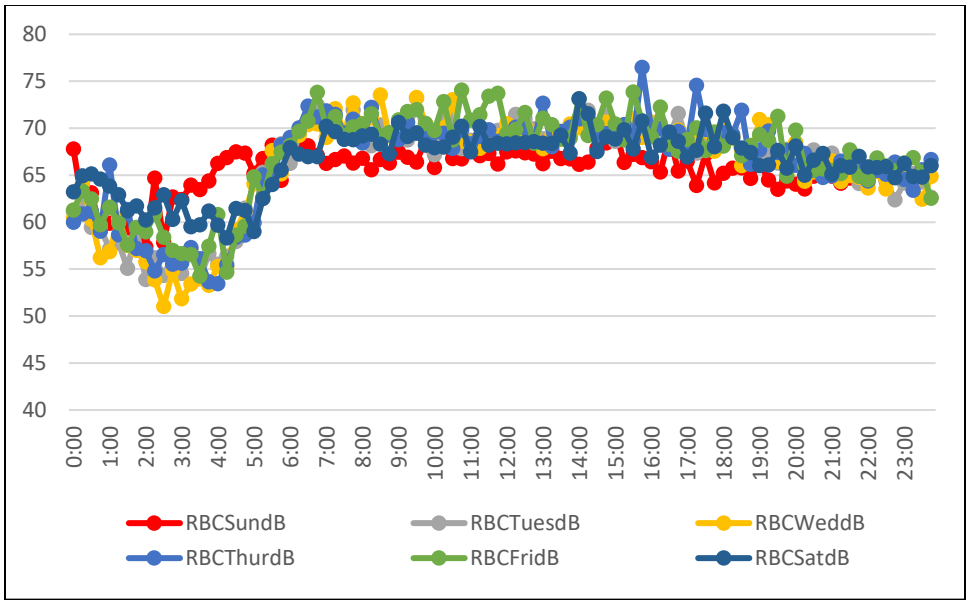
Test Statistics[a]

	RBCTuesdB - RBCSundB	RBCWeddB - RBCSundB	RBCThurdB - RBCSundB	RBCFridB - RBCSundB	RBCSatdB - RBCSundB
Z	-2.341[b]	-2.310[b]	-3.124[b]	-4.288[b]	-4.997[b]
Asymp. Sig. (2-tailed)	.019	.021	.002	.000	.000

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Figure 12: Variation of L_{Aeq} values over the week at Royal Bank of Canada



The Wilcoxon Signed Rank Test showed that at GH Trents building, Sunday's sound levels were statistically different to every other day of the week with Sunday being generally quieter. A graph showing the L_{Aeq} over the week is also provided in Figure 13. This was the norm in other parts of the island where Sunday was typically the quietest day of the week.

Table 5: Results of Wilcoxon Signed Rank Test for GH Trents Building comparing Sunday's L_{Aeq} values with other weekday L_{Aeq} values

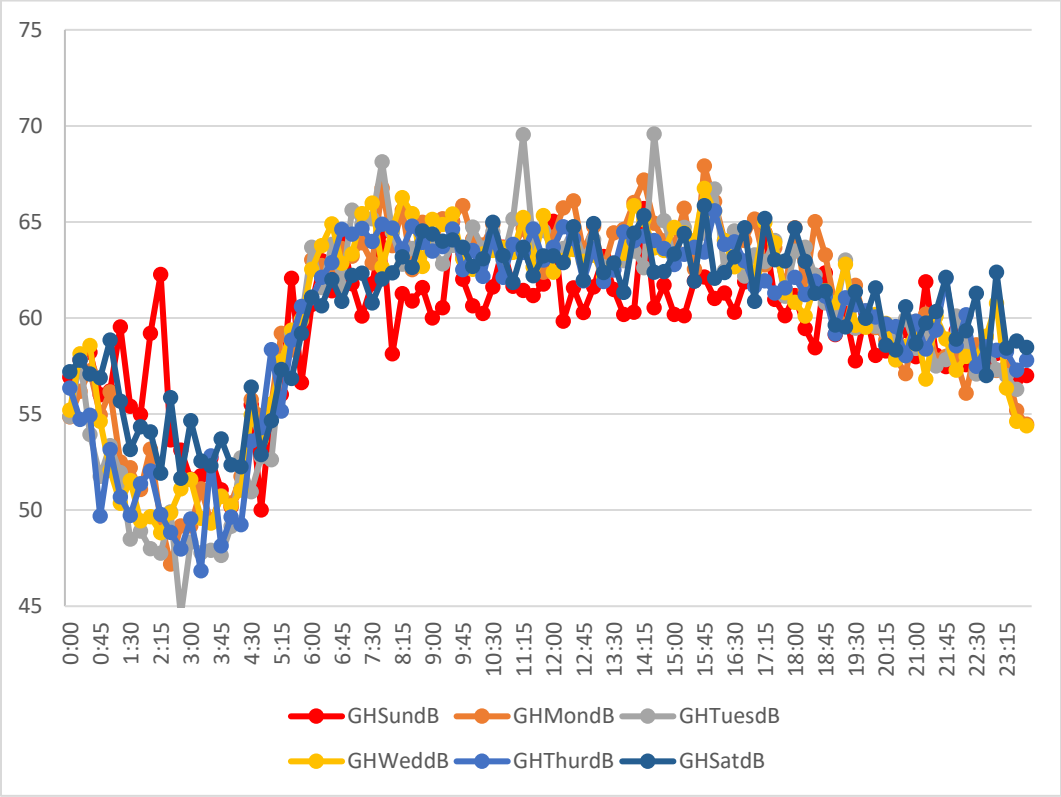
Test Statistics[a]

	GHMondB - GHSundB	GHTuesdB - GHSundB	GHWeddB - GHSundB	GHThurdB - GHSundB	GHSatdB - GHSundB
Z	-3.203[b]	-1.973[b]	-2.914[b]	-2.147[b]	-4.497[b]
Asymp. Sig. (2-tailed)	.001	.048	.004	.032	.000

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Figure 13: Variation of L_{Aeq} values over the week at GH Trents building comparing Sunday's L_{Aeq} values with other weekday L_{Aeq} values



The Wilcoxon Signed Rank Test showed that at Beach House, Sunday's sound levels were generally statistically different to those levels recorded during the week (See Table 6). This trend was similar to the cultural norm. A graph showing the L_{Aeq} over the week is also provided in Figure 14.

Table 6: Results of Wilcoxon Signed Rank Test for Beach House comparing Sunday's L_{Aeq} values with other weekday L_{Aeq} values

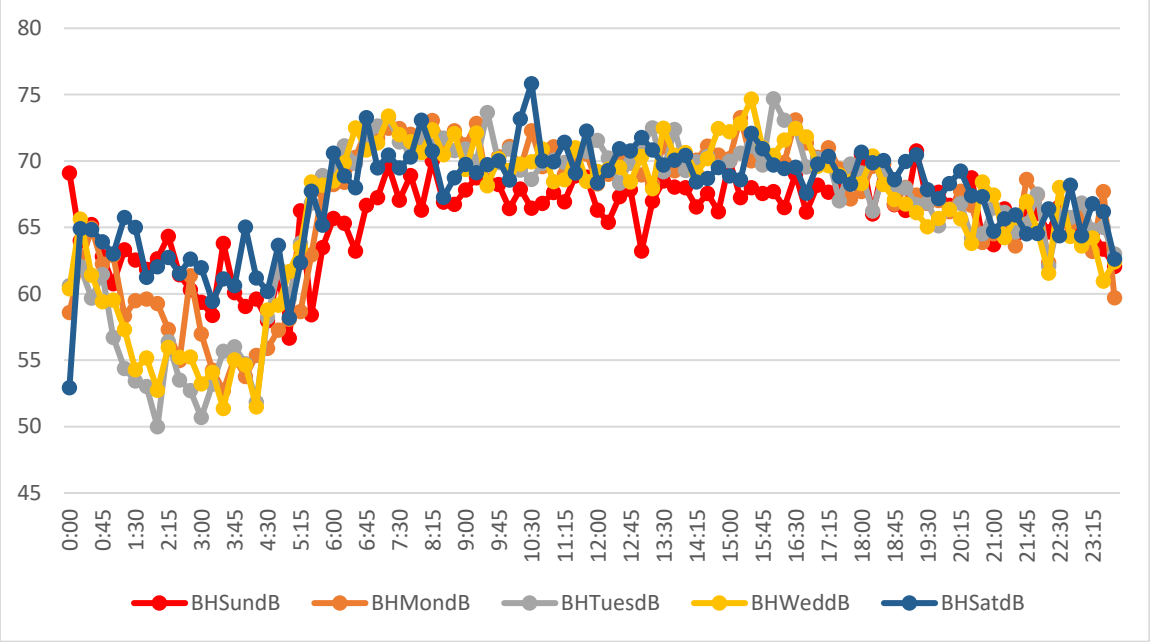
Test Statistics[a]

	BHMondB - BHSundB	BHTuesdB - BHSundB	BHWeddB - BHSundB	BHSatdB - BHSundB
Z	-2.763[b]	-2.054[b]	-1.725[b]	-6.384[b]
Asymp. Sig. (2-tailed)	.006	.040	.085	.000

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Figure 14: Variation of L_{Aeq} values over the week at Beach House comparing Sunday's L_{Aeq} values with other weekday L_{Aeq} values



In Barbados Sundays are typically quieter than other days of the week and this trend was generally noted at all the sites in Holetown. It was however noted that there seems to be a loud activity which occurred in early Sunday morning hours.

Was there a correlation between the traffic counts and the noise levels recorded?

"The relationship between L_{Aeq} and traffic counts was investigated using Spearman's rank order correlation. At all the sites there was a strong, positive correlation between the two variables."

The correlation between traffic counts and noise levels was investigated using the Spearman's rank order correlation for each site. Spearman's rank order correlation was used to determine the strength and direction of the relationship between the two variables. The sign (positive or

negative) indicated the direction of the relationship. A positive correlation coefficient would indicate that as traffic increased the noise levels increased while a negative correlation coefficient would indicate that as traffic decreased the noise levels increased. The value of the coefficient indicated the strength of the relationship. The ranges provided in Table 7 were used to describe the strength of the relationship (Cohen, 1988). The traffic count data is provided in Appendix 7 .

Table 7 : Ranges used in description of the strength of the relationship

Range of r values	Interpretation
r=.10 to .29 or r=-.10 to -.29	Small
r=.30 to .49 or r=-.30 to -.49	Medium
r=.50 to 1.0 or r=-.50 to -.1.0	Large

At all the locations- RBC, GH Trents and Beach House - there was a strong, positive correlation between the fifteen (15) minute L_{Aeqs} and the fifteen (15) minute traffic counts. These results suggest that as traffic levels increased the sound levels increased at the locations. Additionally the survey of noise sources at each site revealed that traffic was the most observed activity at all the sites. The results of the statistical analysis for each monitoring location are below:

Table 8: Correlation analysis of 15 minute L_{Aeqs} with 15 minute traffic counts at the RBC

Day	Spearman Rank Order Correlation Coefficient**	Correlation Description
Sunday	0.709	Strong positive correlation
Tuesday	0.853	Strong positive correlation
Wednesday	0.808	Strong positive correlation
Thursday	0.791	Strong positive correlation
Friday	0.772	Strong positive correlation
Saturday	0.736	Strong positive correlation

** Correlation is significant at the 0.01 level (2-tailed).

Table 9: Correlation analysis of 15 minute L_{Aeqs} with 15 minute traffic counts at GH Trents building

Day	Spearman Rank Order Correlation Coefficient**	Correlation Description
Sunday	0.562	Strong positive correlation
Monday	0.855	Strong positive correlation
Tuesday	0.816	Strong positive correlation

Day	Spearman Rank Order Correlation Coefficient**	Correlation Description
Wednesday	0.861	Strong positive correlation
Thursday	0.840	Strong positive correlation
Saturday	0.802	Strong positive correlation

** Correlation is significant at the .01 level (2-tailed).

Table 10: Correlation analysis of 15 minute L_{Aeqs} with 15 minute traffic counts at Beach House

Day	Spearman Rank Order Correlation Coefficient**	Correlation Description
Sunday	0.665	Strong positive correlation
Monday	0.872	Strong positive correlation
Tuesday	0.865	Strong positive correlation
Wednesday	0.821	Strong positive correlation
Saturday	0.699	Strong positive correlation

** Correlation is significant at the .01 level (2-tailed).

It should be noted that the above results only indicated if high traffic counts and high sound levels (or vice versa) tend to occur together. Whether this link was a direct link or indirect link was not investigated. For example, increased traffic counts could mean an increase in other sources of noise e.g., person related sounds and general business activity which could instead be the direct factor(s) for increased sound levels. In summary, the study found that an increase of traffic volume was associated with an increase in noise levels at all the sites.

7.0 Discussion

Holetown, one of Barbados' major towns, located along the west coast of Barbados was the focus of this noise characterization project. The project involved surveillance of the activities carried out in the area, monitoring of sound levels, collecting data on traffic counts and weather conditions, analysis of the data, writing of a final report and close out of project.

The monitoring locations used were RBC, GH Trents and Beach House. The results indicated that the sound levels at Beach House and RBC were higher than those at the GH Trents site. Visual inspection of the graphs in Appendix 2 revealed that the sound levels generally rose around 5:00 am and dipped around 8:00 pm. In Barbados Sundays are typically quiet and this trend was generally noted at all the sites.

The sound levels in all the areas monitored met the WHO guidelines for industrial, commercial shopping and traffic areas (i.e. L_{Aeq} of 70dB and a L_{Amax} of 110dB over a 24hr period) as the (L_{Aeq}) for the three sites ranged from 60 to 70dBA and the L_{Amax} varied from 89 to 104dBA. The areas of Holetown monitored were largely commercial. It was desired to set up a monitor within the residential area within wider Holetown but finding a suitable secure house that would allow permission proved difficult. It should however be noted that given the (L_{Aeq}) for the three sites ranged from 60 to 70dBA that any residences on the fringes of the main commercial area may experience sound levels above 55dBA during the day. The lack of a buffer area between incompatible land uses could present a challenge. Additionally it can be difficult to use the World Health Organization's Community Guidelines in mixed use areas as the guidelines often do not account for mixed use areas but provide noise limits for individual zones/areas e.g. strictly residential or strictly commercial. It would therefore be prudent to manage the sound levels within Holetown to prevent the WHO commercial noise limits from being exceeded as well as to not cause any further possible noise increases on residential areas that are nearby. Suggested ways of managing the sound levels in Holetown are provided in Section 8.0 Conclusions, Recommendations and Critical Assessment.

As in any typical town, the most observed sources of noise was traffic followed by people (e.g. talking or soliciting of customers). The relationship between L_{Aeq} and traffic counts was

investigated using Spearman's rank order correlation. At all sites there was a strong, positive correlation between the two variables which indicated that as traffic increased at those locations so did the sound levels.

8.0 Conclusions, Recommendations and Critical Assessment

The following conclusions were made:

- In general the noise levels persons were exposed to while in Holetown, at the sites monitored, were within WHO guidelines for community noise for industrial, commercial shopping and traffic areas. No suitable, secure residential site was identified but given the (L_{Aeq}) for the three sites ranged from 60 to 70dBA and the L_{Amax} varied from 89 to 104dBA there is the possibility that residences on the fringes of the mixed use area may experience sound levels above the L_{Aeq} of 55dBA (day) and 45dBA (night) recommended by WHO for residential areas.
- Traffic noise was the main observed activity near the monitoring sites followed by people (talking, liming).
- The relationship between L_{Aeq} and traffic counts was investigated using Spearman's rank order correlation. At all sites there was a strong, positive correlation between the two variables. It should be noted that the above results only indicated if high traffic counts and high sound levels (or vice versa) tend to occur together. Whether this link was a direct link or indirect link was not investigated. For example, increased traffic counts could mean an increase in other sources of noise e.g. person related sounds and general business activity which could instead be the direct factor(s) for increased sound levels.
- The L_{Aeq} values recorded on Sundays were quieter than any other day of the week at all the sites. This is in keeping with the historical trend for Sundays.

The following recommendations and critical assessment are made:

  - *There should be an increased focus on gathering sound level data across Barbados as well as educating the public on* the effects of noise.
  - *In order to maintain the sound levels in Holetown at acceptable levels, future projects or programmes planned should take sound levels into consideration.* Not only should existing receptors be considered but also the possible locations of future surrounding receptors. While it is difficult to give exact suggestions as it

depends on factors such as the noise source, proximity of sensitive receptors, time of day that the high sound levels occur, some general noise management options are setting a minimum sound transmission class of building materials, restricting the number of dwellings and density in some areas, noise barriers/buildings, setting buffer areas, enforced cut off times for loud activities and setting up of permanent monitoring stations.

- *Continuous control/ management of the traffic related sound levels within the town*: As traffic levels appear to have an impact on the sound levels in Holetown efforts should be made to control traffic related sounds in the area. Additionally, any new large scale development in/ near the town can impact traffic counts and consequently sound levels. Issues such as the design and conditon of the road network, parking space availability, location of mass transit routes and other issues which can increase/decrease traffic volumes or congestion. Other areas that can help control or manage road traffic noise were paving roads with noise dampening asphalt, maintaining the road surface, encouraging the use of quieter vehicles (e.g. with tax deductions, reduce importation taxes), discouraging the unnecessary use of vehicle horns, use of electric powered buses.
- *Similar baseline data should be collected for other areas in Barbados.*
- *Depending on the purpose of the study/investigation, only areas where short-term sampling during the busiest/noisiest periods exceeds desired limits may require further long-term monitoring*. This could be part of the criteria for site selection, as it would increase the efficiency with which resources are used.
- *Further training and resources should be obtained for capacity building of the Environmental Protection Department and by extension Barbados.*
- A more rigorous method of determining the amount of rainfall (e.g. using a rain gauge) would be better for future projects.

9.0 References

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences (2nd ed.).* Hillsdale, NJ: Lawrence Erlbaum Associates.

Cowan, J. P. (1994). *Handbook of Environmental Acoustics. .* New York: John Wiley & Sons Inc.

Government of Barbados. (2003). *Physical Development Plan, Amended (2003).* Government of Barbados.

World Health Organization:. (1999). *Guidelines for Community Noise.* Retrieved August 3, 2017, from http://www.who.int/docstore/peh/noise/Comnoise-4.pdf

Appendix 1: Meteorological Data

Meteorological data during monitoring at Royal Bank of Canada (29th June- 2nd July 2018)

Date	Temperature (°C)			Wind speed (m/s)			Relative Humidity (%)			Barometric Pressure (mb)		
	Avg	**Min**	**Max**	**Avg**	**Min**	**Max**	**Avg**	**Min**	**Max**	**Avg**	**Min**	**Max**
29/6/2018	28.3	27.0	31.1	2.1	0.0	5.4	68.6	60.5	75.1	1013.6	1012.7	1015.0
30/6/2019	27.7	24.6	31.2	2.2	0.0	6.7	81.6	65.0	100.0	1012.2	1010.9	1013.7
1/7/2019	27.0	24.1	30.5	1.4	0.0	5.4	88.7	63.5	100.0	1012.3	1009.4	1014.5
2/7/2019	27.9	26.1	31.3	1.8	0.0	7.0	75.5	59.7	100.0	1012.7	1011.5	1014.2

Meteorological data during monitoring at GH Trents (30th June – 5th July 2018)

Date	Temperature (°C)			Wind speed (m/s)			Relative Humidity (%)			Barometric Pressure (mb)		
	Avg	**Min**	**Max**	**Avg**	**Min**	**Max**	**Avg**	**Min**	**Max**	**Avg**	**Min**	**Max**
30/6/2019	27.7	24.6	31.2	2.2	0.0	6.7	81.6	65.0	100.0	1012.2	1010.9	1013.7
1/7/2019	27.0	24.1	30.5	1.4	0.0	5.4	88.7	63.5	100.0	1012.3	1009.4	1014.5
2/7/2019	27.9	26.1	31.3	1.8	0.0	7.0	75.5	59.7	100.0	1012.7	1011.5	1014.2
3/7/2019	27.0	23.7	31.1	2.0	0.4	6.7	89.1	68.0	100.0	1013.1	1011.2	1015.9
4/7/2019	27.8	25.1	31.4	2.0	0.0	7.3	80.0	58.9	100.0	1014.2	1013.2	1015.4
5/7/2019	27.7	23.5	30.9	1.9	0.0	6.5	73.9	57.6	100.0	1014.4	1013.2	1016.9

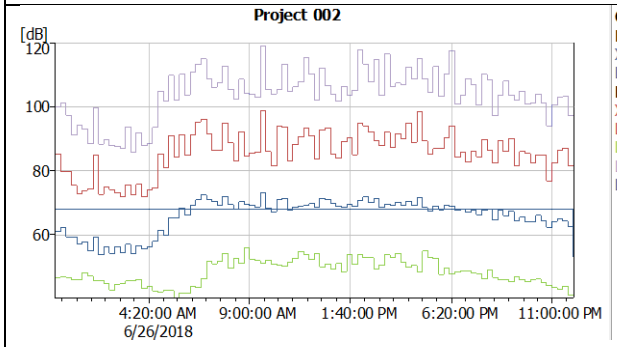
Meteorological data during monitoring at Beach House (8th - 19th September 2018)

Date	Temperature (°C)			Wind speed (m/s)			Relative Humidity (%)			Barometric Pressure (mb)		
	Avg	**Min**	**Max**	**Avg**	**Min**	**Max**	**Avg**	**Min**	**Max**	**Avg**	**Min**	**Max**
08/09/2018	30.1	25.0	42.6	0.1	0.0	1.3	71.3	40.4	91.1	1013.4	1011.7	1015.0
09/09/2018	28.4	24.6	42.5	0.2	0.0	1.8	74.8	37.9	92.2	1012.6	1011.4	1013.9
10/09/2018	29.5	25.1	36.6	0.4	0.0	2.9	72.6	50.5	100.0	1011.7	1010.2	1014.2
11/09/2018	28.8	25.7	36.3	0.2	0.0	2.2	77.2	56.8	93.4	1009.8	1007.7	1012.9
12/09/2018	27.5	23.8	31.8	0.9	0.0	3.8	86.6	53.3	100.0	1010.6	1008.9	1012.7

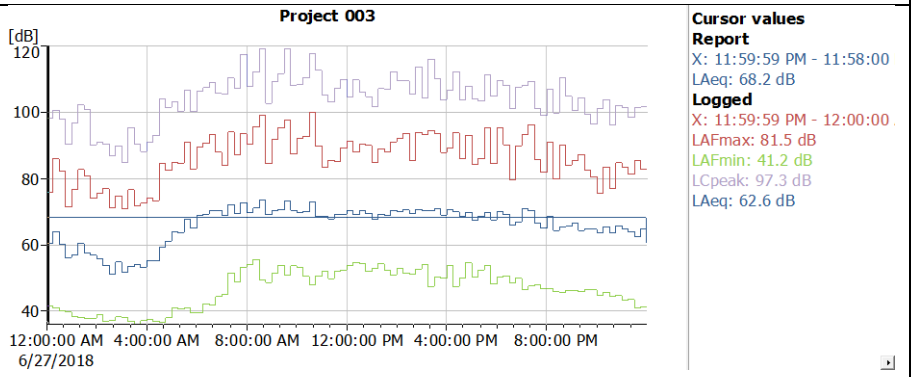
Appendix 2: Graphs of raw noise data

Royal Bank of Canada

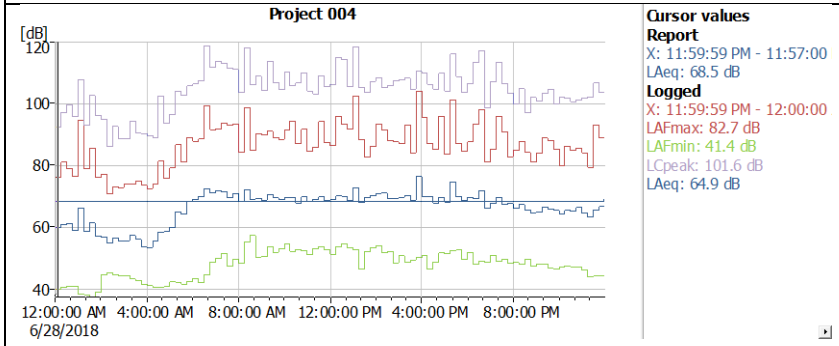
26TH June 2018



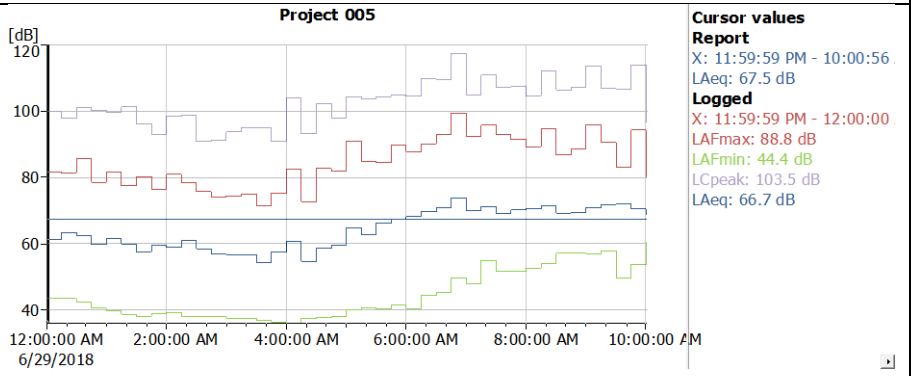
27TH June 2018



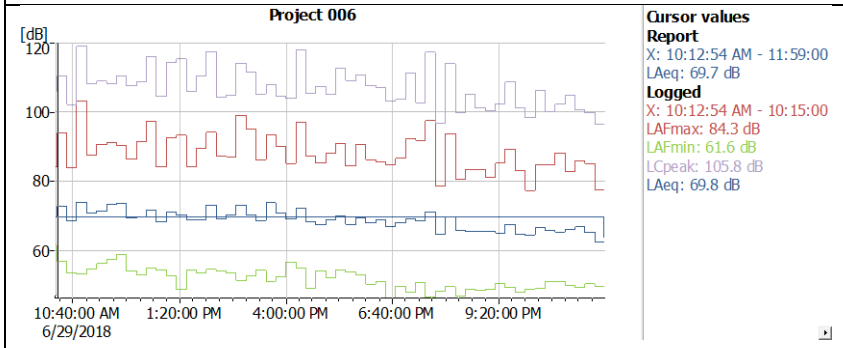
28TH June 2018



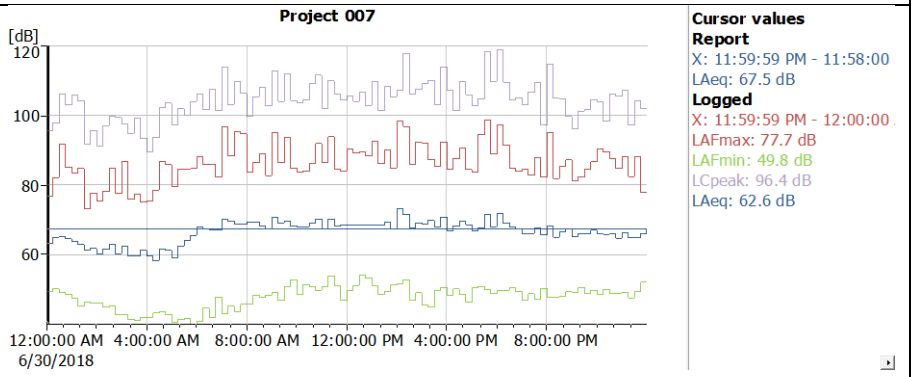
29TH June 2018



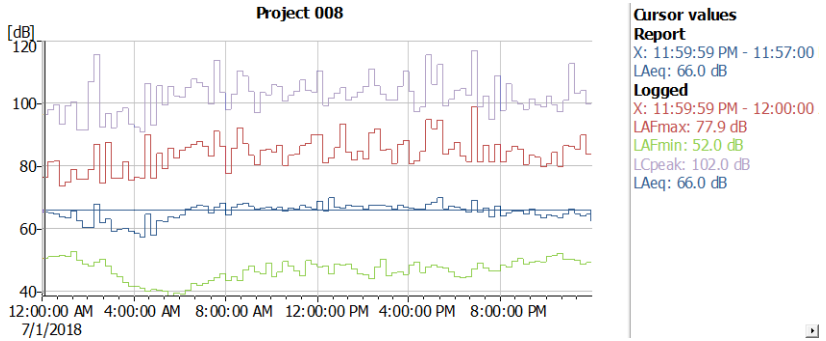
29TH June 2018



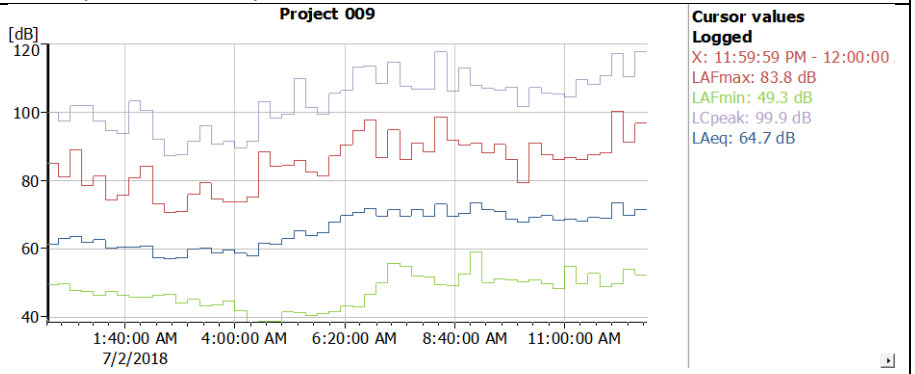
30TH June 2018



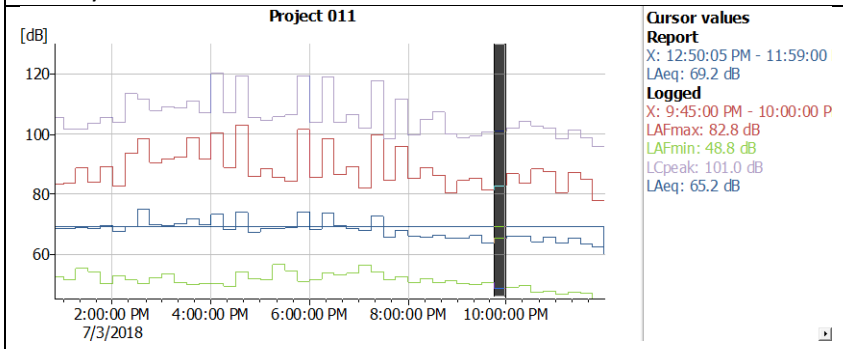
1st July 2018



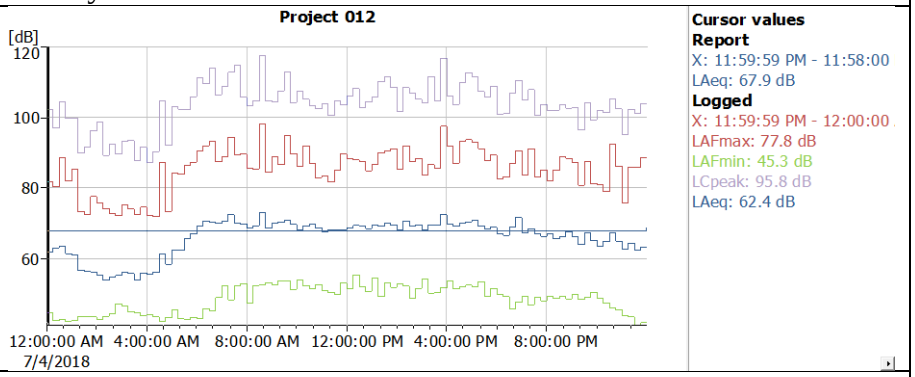
2nd July 2018 (battery died)



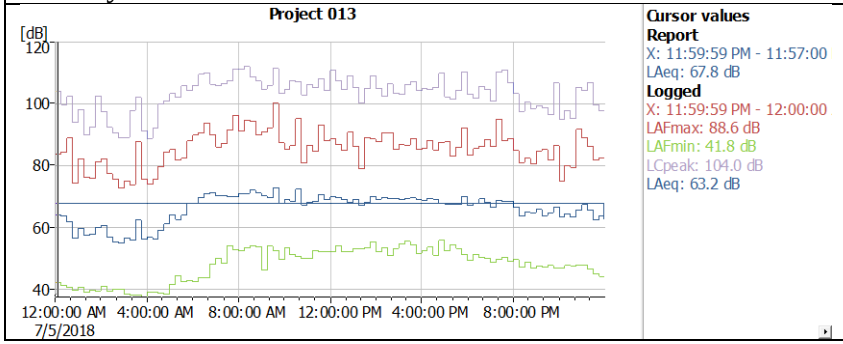
3rd July 2018



4th July 2018

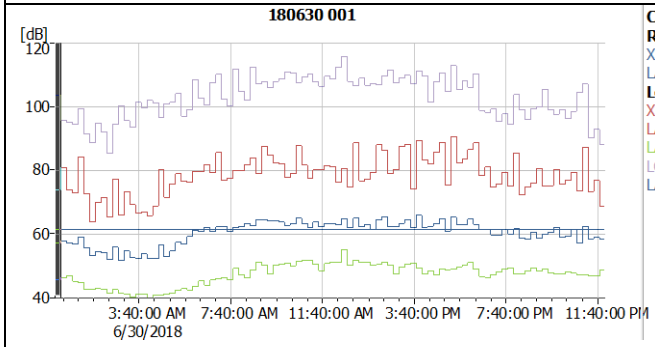


5th July 2018



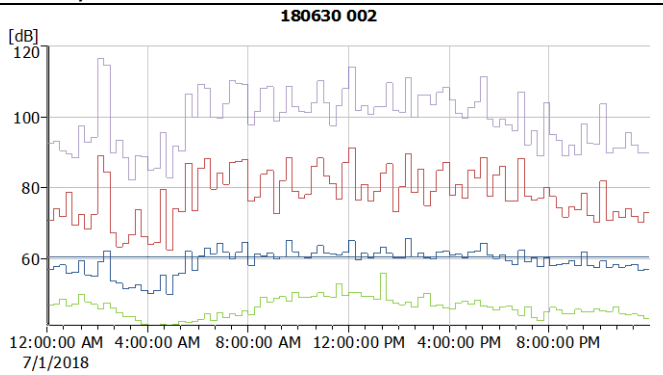
GH Trents Building

30th June 2018



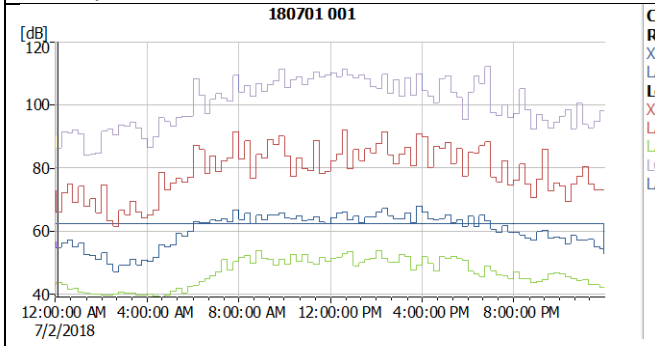
Cursor values
Report
X: 12:00:01 AM - 11:59:00
LAeq: 61.5 dB
Logged
X: 12:00:01 AM - 12:15:00
LAFmax: 73.9 dB
LAFmin: 45.7 dB
LCpeak: 103.4 dB
LAeq: 57.2 dB

1st July 2018



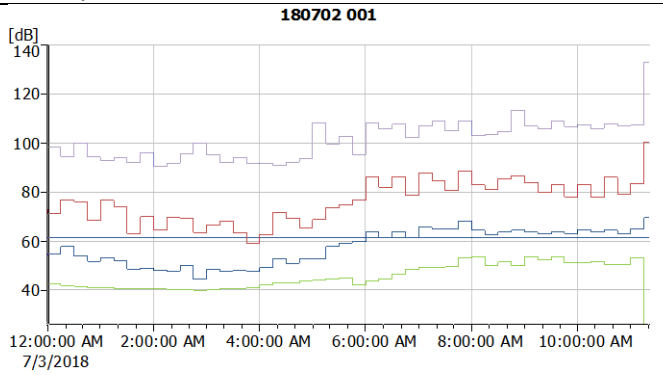
Cursor values
Report
X: 11:59:00 PM - 11:58:00
LAeq: 60.4 dB
Logged
X: 11:59:00 PM - 12:00:00
LAFmax: 68.7 dB
LAFmin: 48.5 dB
LCpeak: 88.1 dB
LAeq: 58.7 dB

2nd July 2018



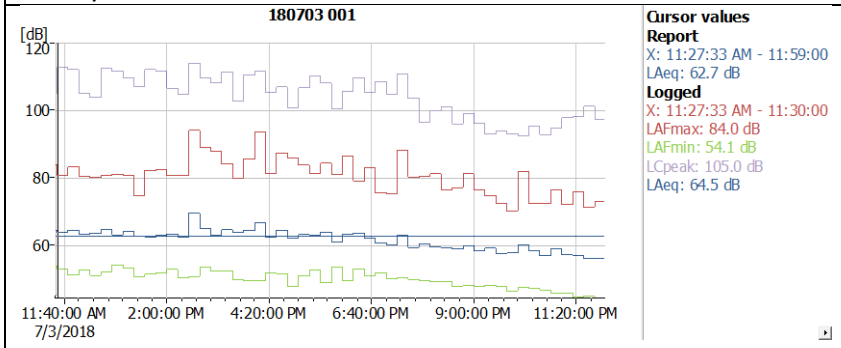
Cursor values
Report
X: 11:59:00 PM - 11:57:00
LAeq: 62.4 dB
Logged
X: 11:59:00 PM - 12:00:00
LAFmax: 73.1 dB
LAFmin: 43.1 dB
LCpeak: 90.0 dB
LAeq: 56.8 dB

3rd July 2018

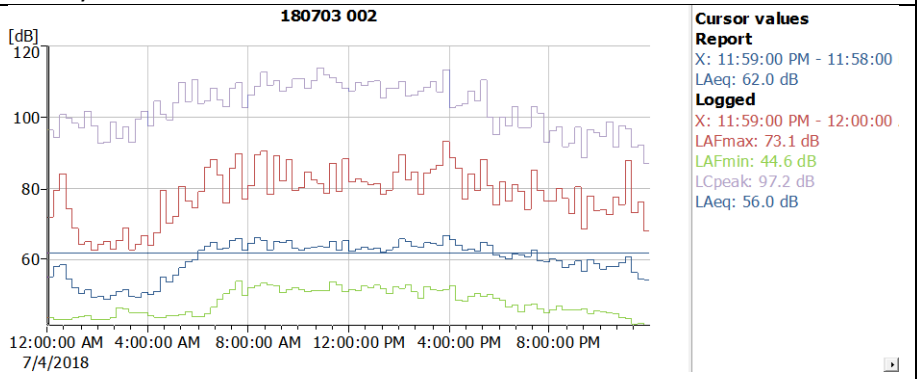


Cursor values
Report
X: 11:59:00 PM - 11:21:40
LAeq: 61.6 dB
Logged
X: 11:59:00 PM - 12:00:00
LAFmax: 73.1 dB
LAFmin: 42.3 dB
LCpeak: 98.2 dB
LAeq: 54.4 dB

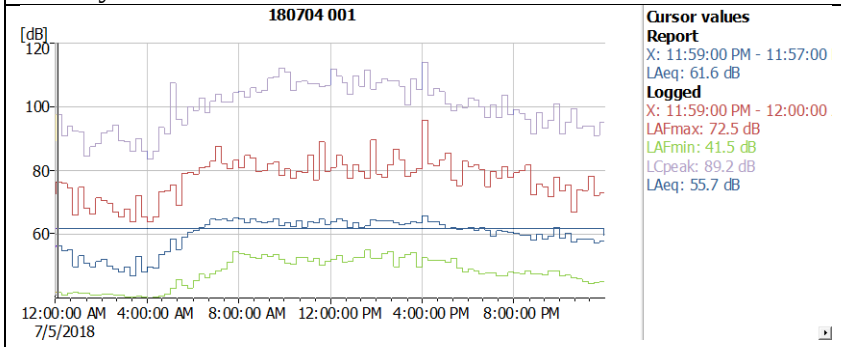
3rd July 2018



4th July 2018

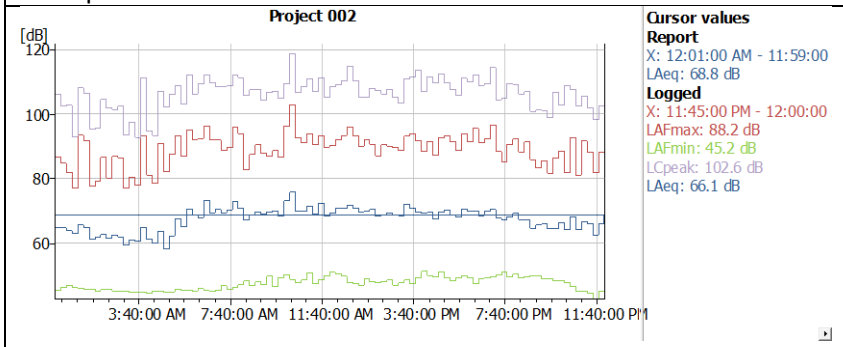


5th July 2018

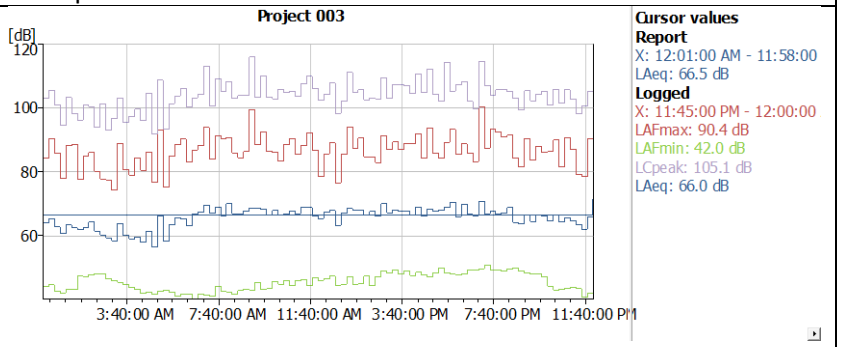


Beach House

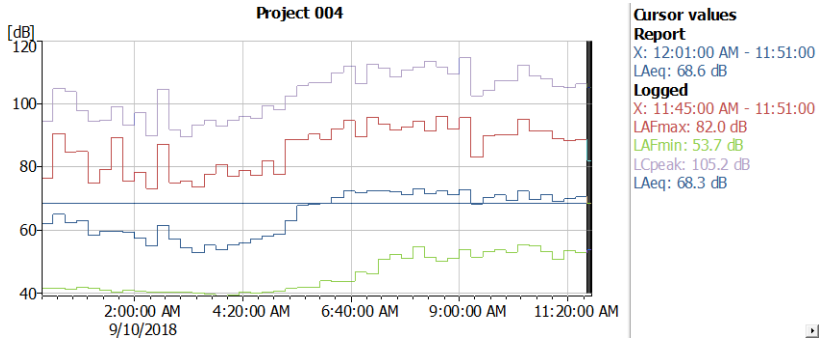
8th September 2018



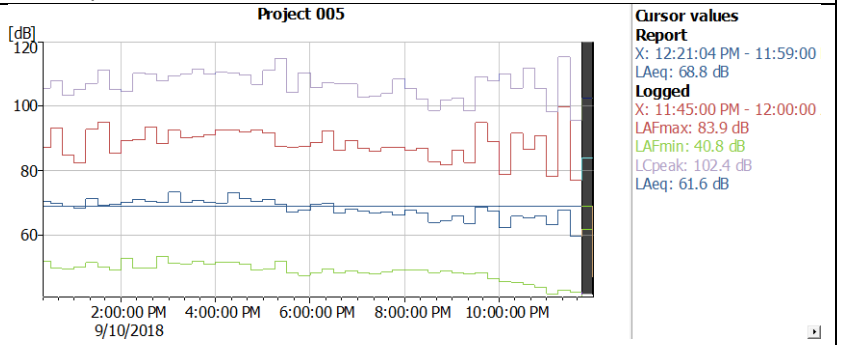
9th September 2018



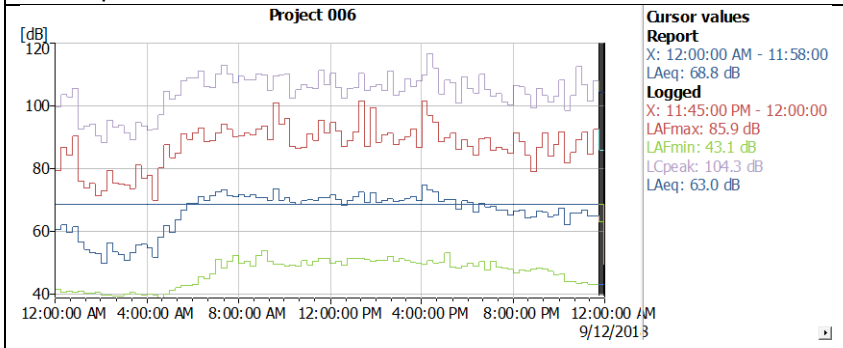
10th September 2018



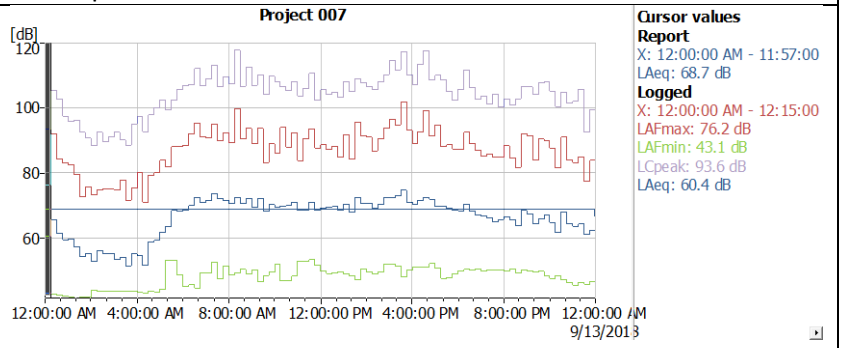
10th September 2018



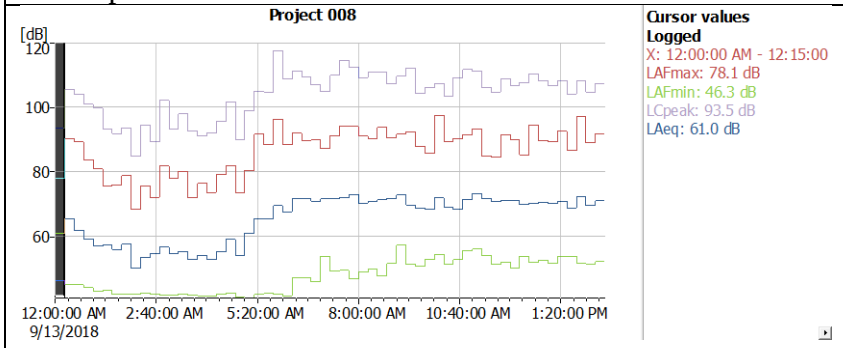
11th September 2018



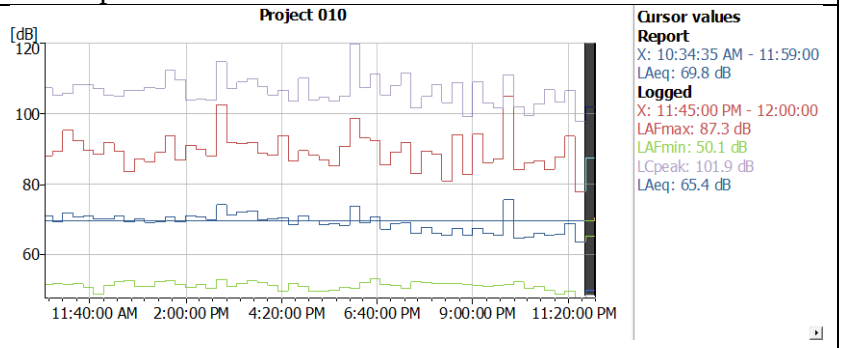
12th September 2018



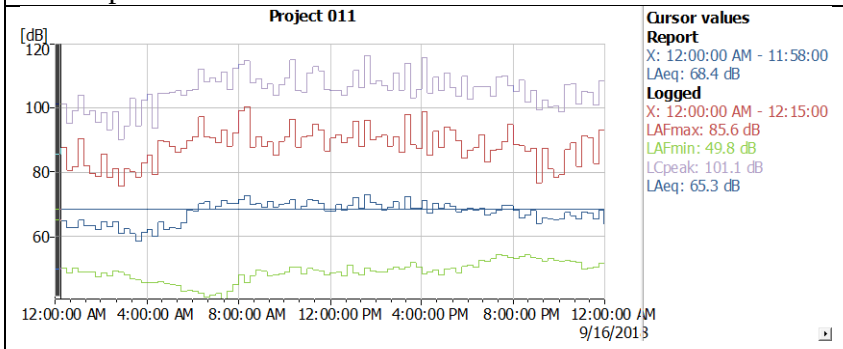
13th September 2018



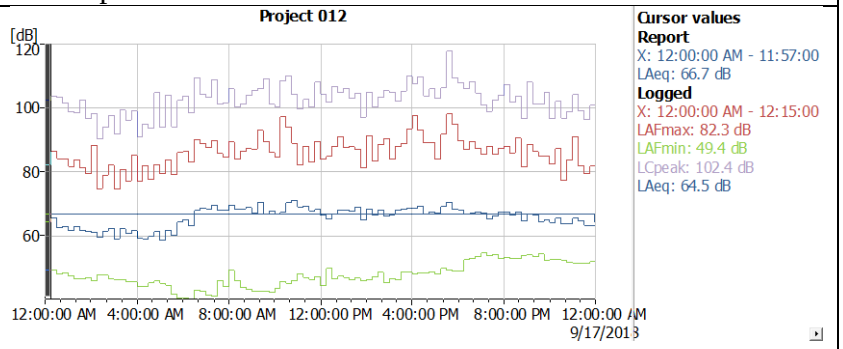
14th September 2018



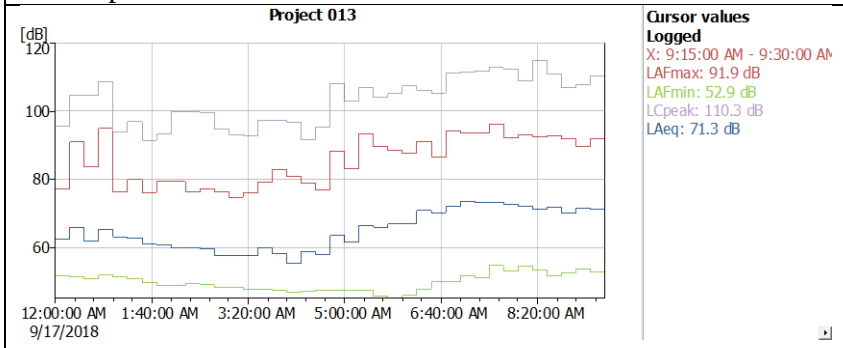
15th September 2018



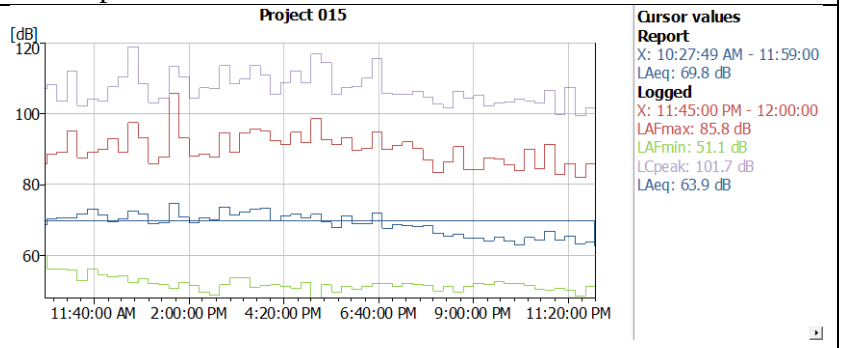
16th September 2018

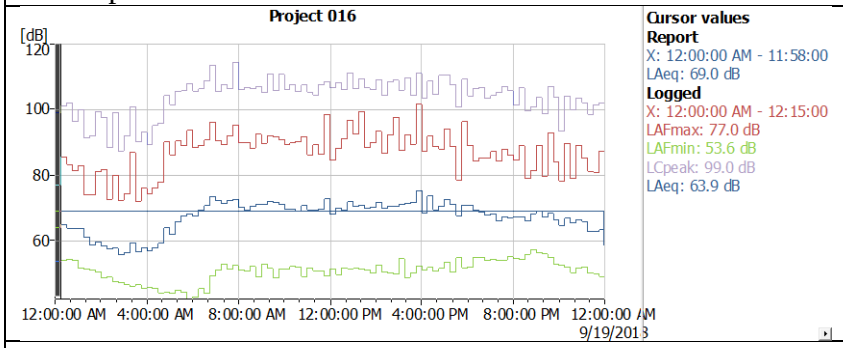
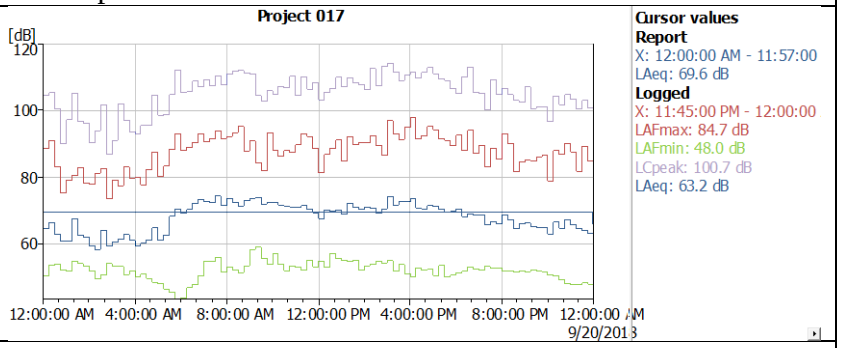


17th September 2018



17th September 2018



18th September 2018	19th September 2018
	

Appendix 3: Stakeholder Contact List

Building Name	**Contact Person Title/Position**	**Mailing Address**	**Contact information**
GH Building (blue with RBC)	Carl Blackman Facilities Manager	Facilities Manager RBC Royal Bank (Barbados) Limited Crn Broad and High Street Bridgetown St. Michael	Carl Blackman (Facilities Manager): [redacted] Chad Stanford , RBC Global Dominion Security (liaison at property), [redacted] Glenda Davis-Holder, Branch Manager, Sunset Crest Branch, RBC Royal Bank (Barbados) Limited, Sunset Crest, St. James- [redacted]
The Trents Building (Orange GH building in Holetown)	Mr. Gerald Hopkin Chairman Ms. Zaeema Motara Personal Assistant Ms. Alison Applewhite Tenant	Grendon Holdings Inc. Sunset Crest Boulevard North Sunset Crest St. James	[redacted] admin@grendonholdings.com Alison Applewhite, Office Manager, MBPI Inc- [redacted]
Beach House	Mr. Dean Alleyne, General Manager Mr. Howard Palmer Owner Ms. Heather Doyan, Beach House	Beach House Sunset Crest Holetown St. James	[redacted]

Appendix 4: Noise measurement form

HOLETOWN NOISE CHARACTERIZATION STUDY 2018
NOISE MEASUREMENT FORM

Location Name: _____ **GPS Coordinates**: N 13 _____ W 59

Address/ Location:

Contact person & number:

Site Description: Description of location (Type of area/zone, activities conducted, topography, nature of ground):

Land Use Designation:

Activities:

Topography:

Nature of ground:

Sound Environment Description: Description and location of (major) sources of ambient noise: (cars, amplified music, steady tone, impulsive, etc.):

Sources:

Instruments& Accessories used:

☐ Brüel&Kjær 2270 SLM S/N:……

☐ Brüel&Kjær 4952 microphone S/N: ……

☐ Brüel&Kjær 4231 calibrator S/N: ……

☐ Internal Battery supply: S/N- ……

☐ External Batteries: ……

☐ Windscreen ☐ Kestrel Weather monitor ☐ Outdoor noise monitoring kit

☐ Other(s): Camera, tripod

General Weather Description

DAY	CLOUDS (/8)	WIND DIRECTION (Degree direction)	WIND SPEED (knots)	DRY BULB (°C)	RH (%)	StN PRESSURE (mbar)	MSL (mbar)	24 HR Rainfall (mm)

Measurement of Noise Levels

Height above ground level: …… Height above floor: ……					Distance from nearest reflective surface (not the ground): ……					Operators: …… ……
Record # in meter	Start Date& Time	End Date & Time	LAeq (dBA)	LAF10 (dBA)	LAF90 (dBA)	LAFmin (dBA)	LAFmax (dBA)	Lcpeak (dBC)	Comments (sounds observed, any extraneous, etc	

Equipment Calibration

Equipment	Calibration Date & Time	Current Sensitivity	Comments
			dB deviation from last
			dB deviation from last
			dB deviation from last
			dB deviation from last
			dB deviation from last

REMEMBER TO:

- Install the SLMs internal battery
- Switch external battery
- Take pictures
- Calibrate SLM
- Re-start meter

Comments

DATE &TIME	COMMENTS

Appendix 5: Instrumentation specifications

Equipment (brand and model)	**IEC compliance**	**Date of last factory calibration**
Bruel & Kjaer 2270 SLM* S/N: 3009267	IEC 61672-1:2002 Class 1 IEC 612:1995 w. Am. 1, 1/1 and 1/3 Oct Band Class 0 IEC 60804:200 Type 1 IEC 60651:1979 w. Am.1&2 Type 1	31st Oct 2017
Bruel & Kjaer 2270 SLM* S/N: 3009263	IEC 61672-1:2002 Class 1 IEC 612:1995 w. Am. 1, 1/1 and 1/3 Oct Band Class 0 IEC 60804:200 Type 1 IEC 60651:1979 w. Am.1&2 Type 1	1st Nov 2017
Bruel & Kjaer 4952 microphone S/N: 3052521	IEC 61672 Class 1 ANSI S 1.40 -1984	25th Oct 2017
Bruel & Kjaer 4952 microphone S/N: 3080409	IEC 61672 Class 1 ANSI S 1.40 -1984	25th Oct 2017
Bruel & Kjaer 4231 calibrator S/N: 2085222	IEC 942 ,1988 Class 1 ANSI S 1.40 -1984	23rd Oct 2017

*SLM- sound level meter,

Appendix 6: Dates traffic counters were deployed

Location	Traffic Counts
Royal Bank of Canada	26th June – 1st July 2018
GH Trents	30th June – 5th July 2018
Beach House	10th July -16th July 2018

Appendix 7: Traffic Counts

	RBC						Pizza Man Doc						Beach House				
Start Time	Sun	Tues	Wed	Thurs	Fri	Sat	Sun	Mon	Tues	Wed	Thurs	Sat	Sun	Mon	Tues	Wed	Sat
0:00	64	28	39	28	44	100	56	44	34	37	59	79	79	59	39	34	71
0:15	60	28	26	37	40	89	50	45	29	29	21	55	60	47	25	33	68
0:30	47	20	26	37	25	81	53	50	17	24	22	69	36	36	19	25	52
0:45	47	20	17	19	27	65	46	37	18	22	16	43	45	44	16	20	58
1:00	49	12	13	27	23	65	37	45	13	21	19	46	44	29	20	16	31
1:15	36	10	16	16	29	61	22	28	10	14	15	45	26	21	9	13	44
1:30	37	5	9	18	17	60	25	23	10	15	17	37	43	25	6	16	37
1:45	25	7	8	13	27	44	25	21	7	11	14	39	33	16	12	17	50
2:00	24	5	7	7	23	49	17	16	5	5	18	38	24	17	6	13	30
2:15	34	7	5	6	27	52	21	11	7	5	11	34	23	15	8	6	39
2:30	29	9	6	7	13	55	17	12	6	4	6	28	22	11	11	9	43
2:45	28	7	6	7	14	34	28	11	1	4	6	27	19	12	5	11	32
3:00	27	7	1	10	14	25	17	12	6	5	7	31	16	6	4	6	25
3:15	22	6	8	11	4	28	17	8	3	6	7	31	23	9	3	7	22
3:30	20	3	8	6	6	41	22	6	3	3	9	22	14	10	2	4	24
3:45	24	6	5	6	15	41	12	16	3	6	5	32	13	10	11	4	27
4:00	13	12	10	7	16	22	13	17	5	6	9	27	7	16	10	8	26
4:15	22	13	10	8	6	33	11	14	11	4	5	13	11	13	11	9	25
4:30	19	13	18	17	14	24	17	14	7	9	12	27	9	23	16	11	32
4:45	16	21	21	19	19	18	17	23	13	12	13	14	15	13	12	21	26
5:00	22	19	24	14	21	21	22	23	10	16	13	13	26	21	13	19	23
5:15	27	30	29	34	30	34	20	28	25	16	23	29	17	21	19	19	30

	RBC						Pizza Man Doc						Beach House				
Start Time	Sun	Tues	Wed	Thurs	Fri	Sat	Sun	Mon	Tues	Wed	Thurs	Sat	Sun	Mon	Tues	Wed	Sat
5:30	26	50	44	46	56	41	30	28	34	34	24	30	49	33	42	47	47
5:45	45	51	52	63	57	52	25	57	39	43	46	36	35	51	52	46	71
6:00	51	79	81	80	83	65	33	57	59	53	56	54	50	78	65	91	72
6:15	61	93	91	109	114	84	52	96	78	97	91	75	57	94	106	97	96
6:30	69	138	154	169	152	96	52	132	110	124	108	80	78	134	127	123	97
6:45	79	225	224	213	207	99	70	158	139	161	143	88	63	183	162	166	105
7:00	82	286	278	277	238	118	74	222	181	186	194	104	111	212	222	215	103
7:15	79	265	257	226	275	122	67	192	212	216	240	102	91	225	221	255	116
7:30	110	272	272	245	293	130	87	147	215	235	225	119	90	256	210	253	126
7:45	90	269	265	289	256	131	96	222	222	203	253	120	103	237	229	248	133
8:00	98	261	255	221	247	138	83	236	260	230	234	140	98	251	244	241	155
8:15	128	266	281	208	234	173	101	255	219	228	224	150	111	245	220	233	168
8:30	148	262	245	235	251	182	111	231	211	262	226	163	138	222	245	250	156
8:45	171	252	245	219	265	178	133	251	211	213	221	150	154	235	224	225	150
9:00	152	231	236	229	240	160	144	223	246	220	205	167	125	210	242	235	140
9:15	146	220	185	215	229	164	150	209	220	225	202	175	138	213	221	193	180
9:30	152	219	193	246	234	207	114	216	195	221	193	183	123	194	219	193	187
9:45	137	203	206	213	233	196	147	223	178	210	210	178	128	189	237	218	152
10:00	146	229	217	229	240	182	121	197	172	198	183	158	136	178	163	204	214
10:15	153	232	198	189	207	215	119	190	184	200	200	174	140	217	192	206	179
10:30	153	209	200	193	198	210	128	177	207	188	204	204	152	200	217	210	174
10:45	159	216	200	214	242	195	145	201	180	216	215	182	168	207	231	224	165
11:00	156	181	206	223	226	204	154	190	177	216	214	203	153	210	214	200	187

	RBC						Pizza Man Doc						Beach House				
Start Time	Sun	Tues	Wed	Thurs	Fri	Sat	Sun	Mon	Tues	Wed	Thurs	Sat	Sun	Mon	Tues	Wed	Sat
11:15	171	227	211	218	162	209	134	186	197	175	210	206	126	214	185	199	166
11:30	160	210	250	213	141	182	145	187	207	202	192	204	140	213	238	185	184
11:45	177	250	193	234	221	206	169	210	187	221	217	179	147	227	210	191	192
12:00	160	242	234	220	238	213	157	202	229	200	208	218	132	208	201	201	217
12:15	176	202	243	218	242	199	166	216	227	230	215	220	124	216	183	189	215
12:30	165	227	232	253	232	233	150	227	217	206	230	210	139	216	197	211	197
12:45	183	223	226	233	251	209	172	226	203	239	226	221	133	195	189	189	188
13:00	153	240	230	211	232	236	166	235	235	199	223	212	142	197	202	195	185
13:15	177	220	240	226	243	197	176	219	232	209	213	216	143	191	215	225	179
13:30	186	214	206	230	247	207	165	243	227	236	253	222	133	183	203	183	191
13:45	178	232	218	254	246	230	174	222	216	220	239	198	145	214	211	219	190
14:00	174	211	205	220	225	230	170	215	217	217	232	228	147	233	218	227	226
14:15	166	238	213	226	238	194	168	236	199	233	247	228	171	218	208	207	187
14:30	154	234	254	211	237	224	155	230	225	253	236	199	150	200	183	200	197
14:45	166	218	213	231	235	196	169	242	202	205	233	211	121	207	185	210	169
15:00	177	212	246	236	266	205	158	205	215	192	224	206	155	180	213	203	224
15:15	140	210	198	201	234	225	156	222	210	192	238	203	138	198	205	170	232
15:30	152	205	218	212	206	184	141	235	194	225	201	214	143	195	208	163	227
15:45	183	225	210	227	223	202	149	227	207	222	195	189	168	215	157	177	171
16:00	172	223	236	241	243	178	171	208	199	236	228	177	169	257	200	183	197
16:15	152	209	234	245	225	193	171	236	235	233	236	210	140	244	221	201	184
16:30	152	221	291	263	218	244	143	238	229	240	224	193	164	223	220	210	212
16:45	193	239	228	260	226	199	146	263	231	247	254	243	147	215	205	210	199

	RBC						Pizza Man Doc						Beach House				
Start Time	Sun	Tues	Wed	Thurs	Fri	Sat	Sun	Mon	Tues	Wed	Thurs	Sat	Sun	Mon	Tues	Wed	Sat
17:00	195	196	241	246	196	227	201	202	261	238	257	192	166	242	220	204	174
17:15	182	229	252	237	211	196	176	238	194	234	244	212	165	215	216	192	186
17:30	183	212	241	204	242	184	187	226	213	225	250	207	132	198	213	165	184
17:45	153	204	201	234	171	210	168	230	214	209	224	199	165	175	240	218	166
18:00	165	178	228	187	180	218	139	194	193	206	189	225	162	207	185	208	223
18:15	212	190	213	196	191	188	174	189	187	178	222	196	169	177	171	191	167
18:30	164	191	173	196	150	195	171	206	167	180	180	191	150	178	171	193	166
18:45	164	183	180	217	179	189	157	171	159	162	186	172	171	202	194	167	197
19:00	194	181	180	182	168	182	177	182	147	164	161	178	163	161	176	182	190
19:15	148	165	196	181	153	195	167	157	119	197	172	178	161	149	158	153	222
19:30	161	178	153	149	189	197	163	141	133	162	155	197	165	128	150	154	178
19:45	154	179	169	168	169	187	139	149	138	151	165	190	173	139	160	178	189
20:00	133	156	134	153	161	178	133	138	109	136	135	157	155	151	140	123	143
20:15	156	137	124	155	155	196	130	136	104	132	109	171	134	121	121	120	137
20:30	140	129	110	130	150	181	121	110	129	105	135	171	115	130	124	132	153
20:45	118	109	126	111	160	180	136	102	82	105	117	179	134	112	113	103	128
21:00	116	127	113	128	155	191	109	108	115	102	108	167	143	110	123	115	121
21:15	117	119	108	127	153	143	104	91	104	116	108	167	118	84	117	117	118
21:30	91	91	105	117	148	156	119	82	87	106	122	141	127	97	100	107	142
21:45	96	105	109	106	132	137	83	75	98	102	115	133	126	73	107	121	117
22:00	102	94	110	122	140	157	97	83	104	94	96	132	116	89	96	72	125
22:15	88	84	97	110	119	160	93	79	95	94	105	144	94	81	96	102	120
22:30	92	99	90	99	143	138	90	79	66	90	81	125	103	74	103	87	112

	RBC						Pizza Man Doc						Beach House				
Start Time	Sun	Tues	Wed	Thurs	Fri	Sat	Sun	Mon	Tues	Wed	Thurs	Sat	Sun	Mon	Tues	Wed	Sat
22:45	79	74	92	85	135	126	87	74	68	83	74	117	110	75	82	83	112
23:00	112	89	79	75	138	109	79	71	65	74	83	115	114	77	78	86	116
23:15	83	95	74	66	88	102	99	64	49	64	71	110	73	59	80	64	97
23:30	55	68	58	51	102	82	75	61	47	36	62	67	49	49	56	45	94
23:45	55	52	58	52	88	83	49	29	41	46	49	72	49	27	30	31	80