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Sound/ Vibration Ongoing Construction Activity Study

Analysis Date: 6 December 2018
Performed By: Ryan Sema
Performed For: Clark Construction

The following equipment was used for all recordings and calibrated to 94dB immediately before and after measurements:

Measuring Equipment (ANSI and IEC Class I)	Calibration Level	Calibration Date
XL2 Analyzer/ Earthworks M23	94dB	June 2018
ND9 Calibrator (94dB @1kHz)	94dB	October 2017

Overview:

A sound/ vibration study was performed by RNS Acoustics at the request of Clark Construction to monitor construction activity for the future location of the North Torrey Pines Living and Learning Center (NTPLL) on the University of California San Diego Campus (UCSD). Sound/ Vibration levels were monitored at various buildings surrounding the project to develop a sound profile for pre- and ongoing construction. Sound monitors were located at Thurgood Marshall Admin, Applied Physics and Mathematics (AP and M), Tenaya Hall, and Extension. Vibration monitors were located at Social Sciences Research Building (SSRB), AP and M, and Mandler Hall. All locations in this report were monitored from November 1 to November 30, and compared to the baseline data gathered from June 4 to June 17. Included in this report are graphs of the noise and vibration data collected while construction was taking place, as well as graphs that illustrate the difference between the baseline data and the data gathered during construction activities. Attached to this report in the appendix are the data used to create the graphs. These graphs and tables will be used to determine if/when abnormal sound/ vibration events are occurring due to construction activities. In the event of an excessive noise/vibration event, Clark Construction will be notified in order to implement mitigation procedures where necessary.

Definition of Terms and Limits:

LAeq – The equivalent continuous sound level. This single number value represents the level of noise that contains the same amount of energy as a time varying signal. The limit set forth by Clark Construction is 75 dBA LAeq over the 12 hour work day.

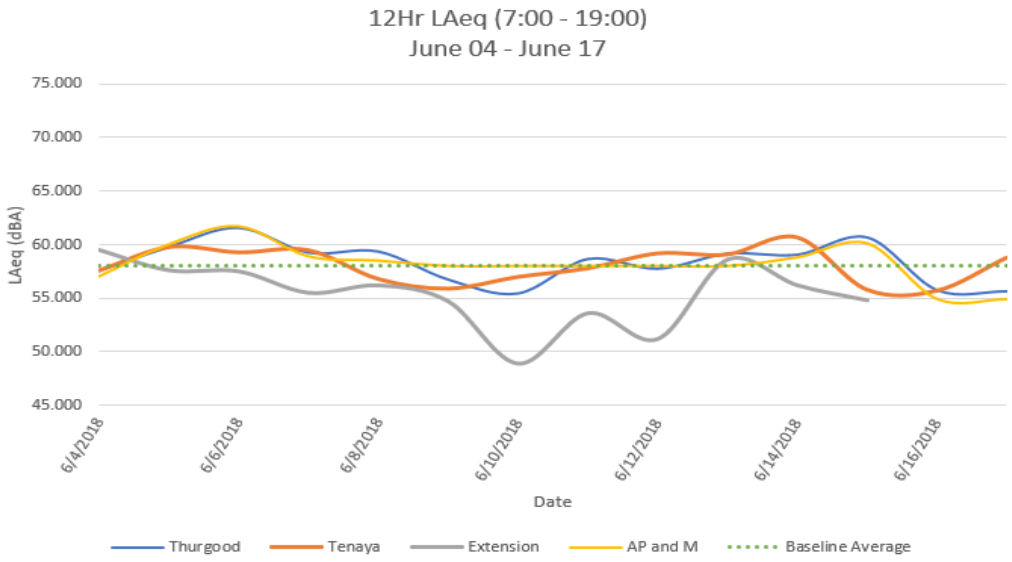
A-Weighting – The level in decibels as measured on a sound level meter using the A- Weighted network. The A-Weighted network is the network for measuring sound that most closely resembles what the human ear hears. Sound measured using the A-weighted network is designated dBA.

Pk-Pk Velocity – A measure of the peak to peak value of a waveform caused by vibration. The units are Inch/ Second.

Findings:

The following sections provide graphs that display the recorded data during the construction activities study at the various locations listed above. The gathered data uses the prior baseline study as a reference in determining the overall impact of construction sound/vibration.

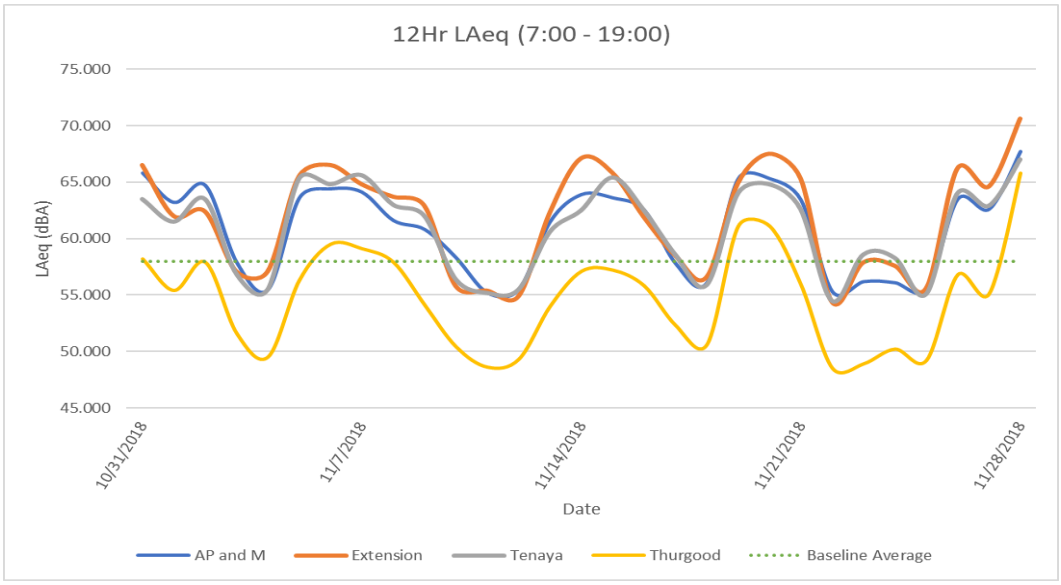
Pre-Construction Sound Levels:



Graph 1. Pre-Construction Sound Levels

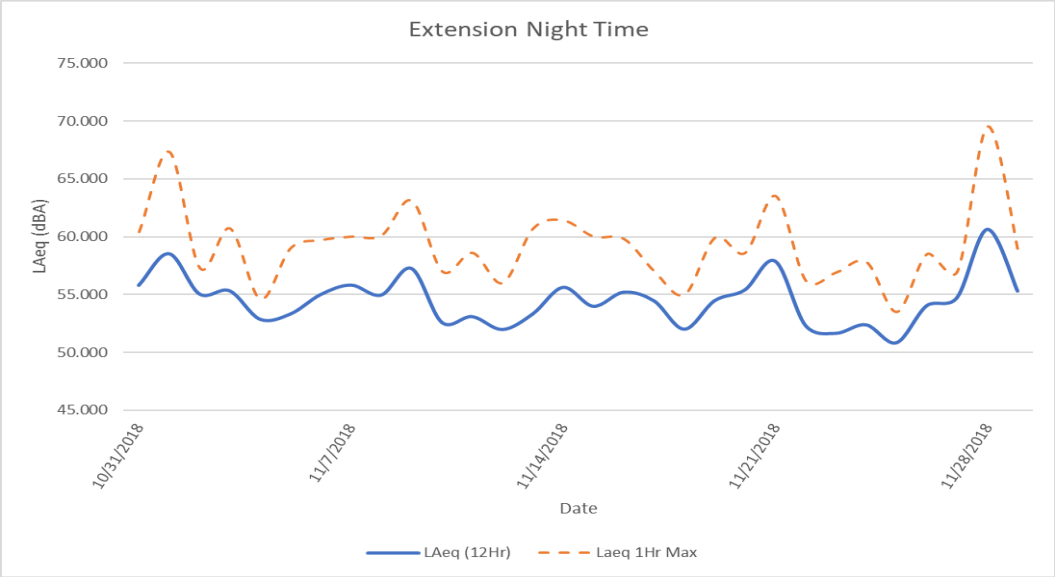
Graph 1 shows the pre-construction 12Hr LAeq data gathered from June 04 -June 17. The values vary between 55 – 61dBA. Data from AP and M gathered between the dates June 09 – June 13 were corrupted due to a technical problem with the microphone. The invalid data was omitted and set to the baseline average. The Extension baseline data was collected between May 23 – June 3 and overlayed onto the data collected between June 04 – June 17 for simplicity and coherent comparison.

Active Construction Sound Levels:



Graph 2. Active Construction Sound Levels

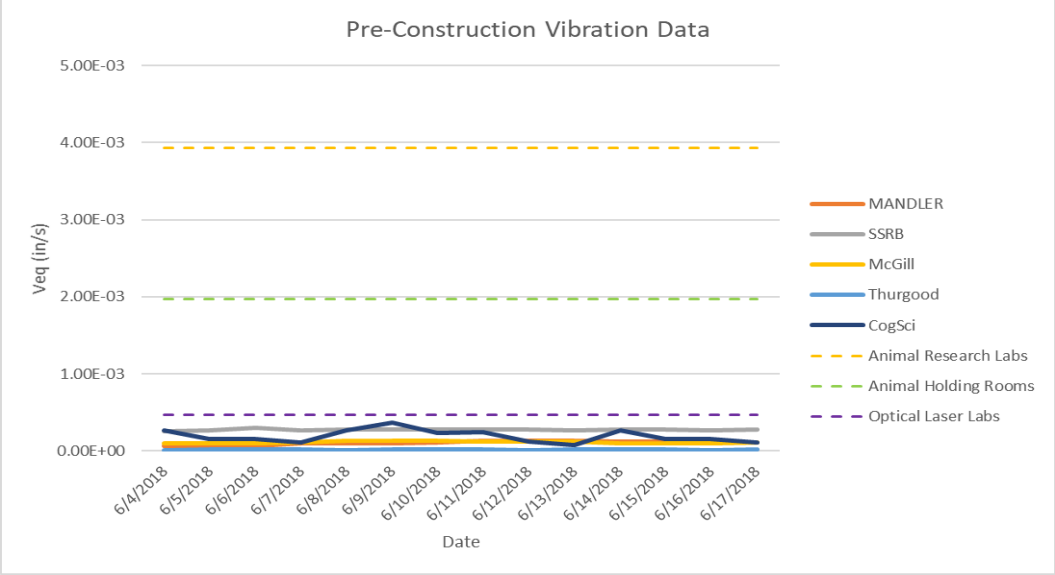
As can be seen in Graph 2, the 12Hr LAeq sound levels do not exceed the limit of 75 dBA and are typically between 55 – 70 dBA. Overall, with the exception of Thurgood, there has been an overall increase in noise relative to the baseline study. An average of the Baseline LAeq was included for reference. Due to the levels being lower than the required limit of 75 dBA for the 12 hour period, a warning is set at 75 dB LAeq-1hr to ensure that mitigation measures can be taken if needed. Sound levels were measured during active construction hours from 7:00 to 19:00.



Graph 3. Extension Night Sound Levels

As can be seen in Graph 3, the 12Hr LAeq (solid line) sound levels for Extension vary between 50 – 56 dBA, and the maximum 1Hr LAeq (dashed line) varies between 55 – 64 dBA for each night. The 12Hr LAeq provides the average sustained noise levels for the entire night, while the LAeq 1Hr Max is more representative of the peak sustained noise level for any given night. The Extension night data contains measurements taken between the hours of 20:00 – 7:00 from November 1 – November 30.

Pre-Construction Vibration Levels:

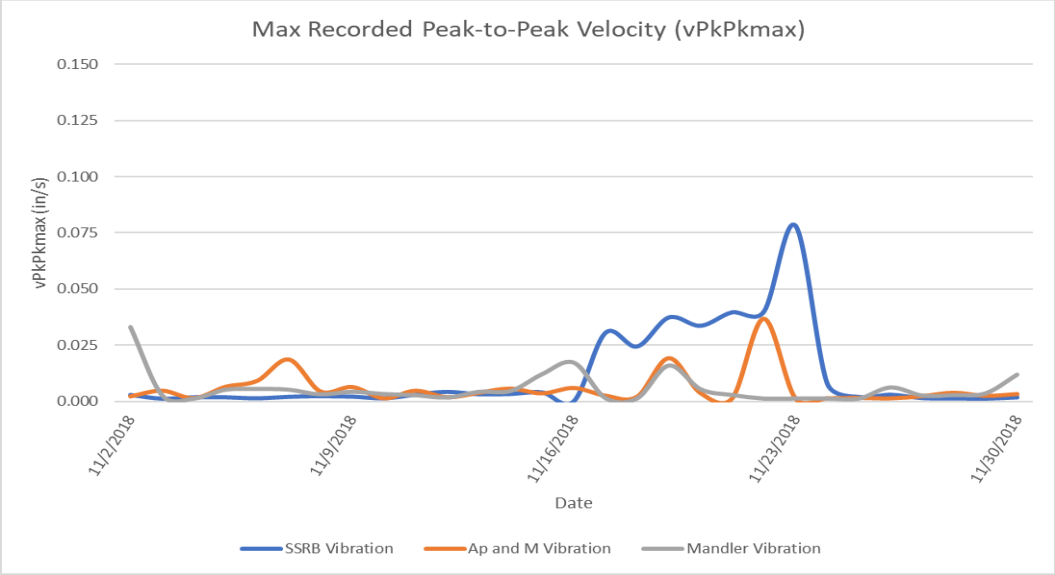


Graph 4. Pre-Construction Vibration Levels

Graph 4 shows the vibration data gathered from the baseline study conducted before construction at various locations. Excessive overloading and interference conditions skewed the AP and M data such that it no longer accurately represented ambient conditions, and it has been omitted.

Note: Data from McGill was taken from June 8 – 17, Thurgood from June 03 – 07, and CogSci from June 13 – 23. Since the data intervals are shorter than 2 weeks, they were repeated, and the data was overlayed onto the June 04 – 17 axis for simplicity and coherence.

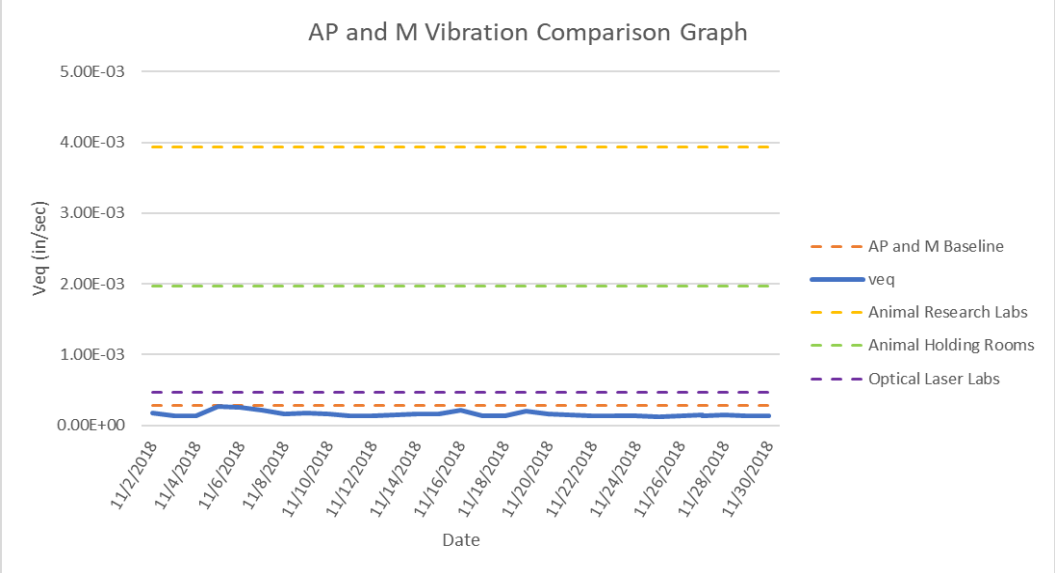
Active Construction Vibration Levels:



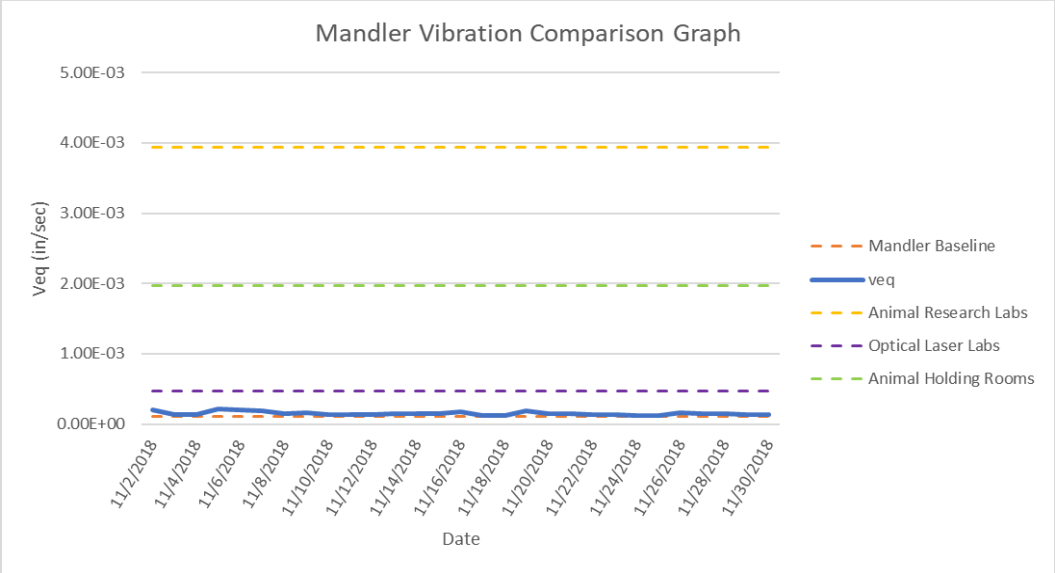
Graph 5. Active Construction Vibration Levels

According to the data collected for Graph 5, the active construction maximum vibration levels do not exceed 0.150 in/s peak-to-peak velocity (vPkPk), and typically do not exceed 0.025 in/s vPkPk. The client will be notified when the measured vPkPk approaches the maximum acceptable vPkPk threshold. The maximum acceptable local vPkPk threshold will be determined after reviewing the data with the client.

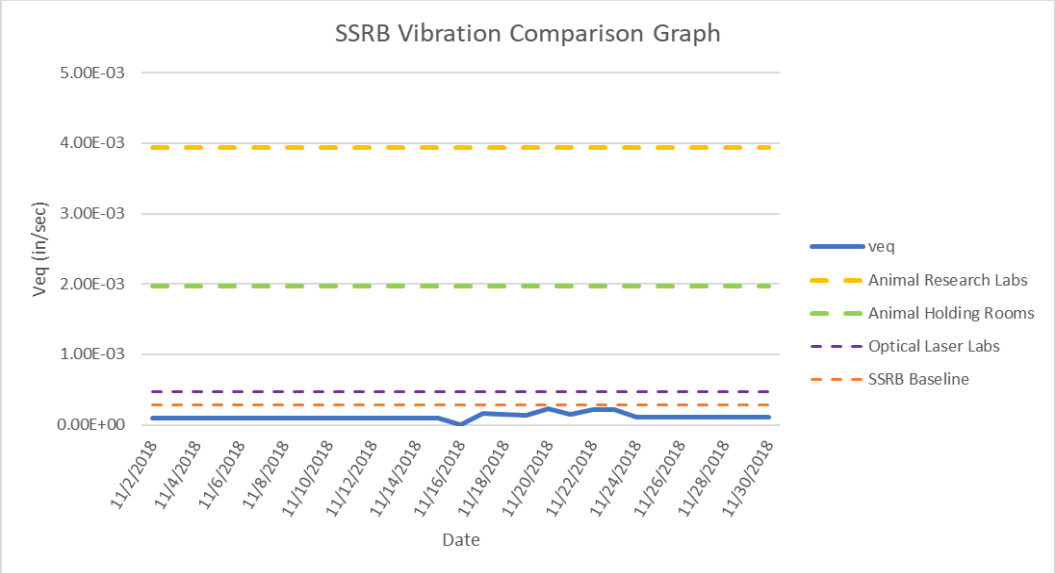
Note: Values in excess of 0.50 in/s vPkPk are likely due to excessive movement near, or unintentional interaction with, the monitoring device. For example, moving tables or chairs near the device can generate ~0.1 – 0.15 in/s vPkPk. Given the irregularity of the data points over 0.05 in/s with respect to the data as a whole, it is unlikely that they can be attributed to regular construction activities.



Graph 6. Comparison Graph of AP and M vs Mandler Baseline Average



Graph 7. Comparison Graph of Mandler vs Mandler Baseline Average



Graph 8. Comparison Graph of SSRB vs SSRB Baseline Average

Graphs 6-8 plot the baseline vibration data (red line) for each location with the corresponding ongoing construction data (blue line) for each location, except AP and M. Excessive overloading and interference conditions skewed the AP and M data such that it no longer accurately represented ambient conditions, and the baseline level of Mandler was used for AP and M. The baseline data was averaged to give a general representation of relative vibration values. Graphs 6-8 show that no substantial contributions to ambient vibration levels were made by ongoing construction activities in any of the monitored locations. As a general reference, all vibration levels recorded were below the approximate human vibration perception threshold of 3.00E-02 in/s. Animal Research Labs, Animal Holding Rooms and Optical Laser reference values obtained from NIH Design Requirements Manual (Issuance Notice 12/12/2016) from www.orf.od.nih.gov.

Note: Overload data was omitted for Graphs 6 – 8. Overloads typically occur due to accidental disruption to the accelerometer or excessive movement near the device location. Activities of this sort could provide false readings and not be indicative of actual construction activities. If the number of overload occurrences is deemed to be excessive, the devices in these areas can be relocated to a more secure environment with less activity for the duration of the project. The data including the overload occurrences are included in the appendix.

Appendix A: Vibration Data

SSRB Vibration	0	0	0	Ap and M Vibration	0	0	0
Date	veq	vPkPkmax	Overload	Date	veq	vPkPkmax	Overload
11/30/2018	1.03E-04	1.78E-03	0	11/30/2018	1.41E-04	3.27E-03	0
11/28/2018	1.02E-04	1.34E-03	0	11/28/2018	1.54E-04	3.84E-03	0
11/29/2018	1.03E-04	1.20E-03	0	11/29/2018	1.41E-04	2.45E-03	0
11/27/2018	1.06E-04	1.46E-03	0	11/27/2018	1.54E-04	2.31E-03	0
11/26/2018	1.12E-04	2.95E-03	0	11/27/2018	1.31E-04	1.32E-03	0
11/25/2018	1.05E-04	1.98E-03	0	11/24/2018	1.29E-04	1.57E-03	0
11/24/2018	1.11E-04	8.04E-03	0	11/25/2018	1.28E-04	1.37E-03	0
11/23/2018	2.17E-04	7.81E-02	0	11/23/2018	1.29E-04	1.32E-03	0
11/22/2018	2.12E-04	3.98E-02	0	11/21/2018	1.54E-04	3.69E-02	0
11/21/2018	1.45E-04	3.96E-02	0	11/22/2018	1.29E-04	1.32E-03	0
11/20/2018	2.27E-04	3.36E-02	0	11/20/2018	1.56E-04	3.73E-03	0
11/19/2018	1.41E-04	3.73E-02	0	11/19/2018	2.06E-04	1.93E-02	0
11/18/2018	1.43E-04	2.44E-02	0	11/18/2018	1.30E-04	2.08E-03	0
11/17/2018	1.59E-04	3.05E-02	0	11/17/2018	1.37E-04	2.53E-03	0
11/16/2018	1.05E-02	0.00E+00	0	11/16/2018	2.20E-04	5.99E-03	0
11/15/2018	1.01E-04	3.99E-03	0	11/15/2018	1.58E-04	3.56E-03	0
11/14/2018	1.00E-04	3.27E-03	0	11/14/2018	1.57E-04	5.70E-03	0
11/13/2018	1.00E-04	3.15E-03	0	11/13/2018	1.49E-04	3.83E-03	0
11/12/2018	9.97E-05	4.24E-03	0	11/12/2018	1.34E-04	1.86E-03	0
11/11/2018	1.00E-04	2.97E-03	0	11/10/2018	1.60E-04	4.75E-03	0
11/10/2018	9.98E-05	1.35E-03	0	11/11/2018	1.32E-04	1.33E-03	0
11/9/2018	1.00E-04	2.12E-03	0	11/9/2018	1.80E-04	6.41E-03	0
11/8/2018	1.00E-04	2.34E-03	0	11/8/2018	1.58E-04	4.41E-03	0
11/7/2018	1.00E-04	2.03E-03	0	11/7/2018	2.16E-04	1.87E-02	0
11/6/2018	1.00E-04	1.36E-03	0	11/6/2018	2.52E-04	9.17E-03	0
11/5/2018	1.00E-04	1.82E-03	0	11/5/2018	2.62E-04	6.50E-03	0
11/4/2018	1.00E-04	1.82E-03	0	11/4/2018	1.30E-04	1.42E-03	0
11/3/2018	1.00E-04	1.20E-03	0	11/2/2018	1.78E-04	4.77E-03	0
11/2/2018	1.00E-04	2.86E-03	0	11/3/2018	1.34E-04	2.25E-03	0
1/0/1900	0.00E+00	0.00E+00	0	1/0/1900	0.00E+00	0.00E+00	0

Mandler Vibration	0	0	
Date	veq	vPkPkmax	Overload
11/30/2018	1.39E-04	1.20E-02	
11/29/2018	1.40E-04	2.95E-03	
11/27/2018	1.52E-04	3.69E-03	
11/28/2018	1.53E-04	2.74E-03	
11/26/2018	1.56E-04	6.33E-03	
11/25/2018	1.27E-04	1.37E-03	
11/24/2018	1.27E-04	1.41E-03	
11/23/2018	1.29E-04	1.41E-03	
11/22/2018	1.29E-04	1.40E-03	
11/21/2018	1.48E-04	2.97E-03	
11/20/2018	1.54E-04	5.53E-03	
11/19/2018	1.83E-04	1.60E-02	
11/18/2018	1.26E-04	1.49E-03	
11/17/2018	1.27E-04	1.60E-03	
11/16/2018	1.80E-04	1.73E-02	
11/15/2018	1.55E-04	1.22E-02	
11/14/2018	1.52E-04	4.74E-03	
11/13/2018	1.48E-04	4.39E-03	
11/12/2018	1.32E-04	1.84E-03	
11/11/2018	1.29E-04	2.88E-03	
11/10/2018	1.37E-04	3.42E-03	
11/9/2018	1.63E-04	4.41E-03	
11/8/2018	1.55E-04	3.23E-03	
11/7/2018	1.82E-04	5.33E-03	
11/6/2018	2.00E-04	5.64E-03	
11/5/2018	2.10E-04	5.30E-03	
11/4/2018	1.35E-04	1.41E-03	
11/3/2018	1.36E-04	2.83E-03	
11/2/2018	2.01E-04	3.30E-02	
1/0/1900	0.00E+00	0.00E+00	

Appendix B: LAeq Data

AP and M	[dB]	Extension	[dB]	Tenaya	[dB]	Thurgood	[dB]
10/31/2018	65.8	10/31/2018	66.5	10/31/2018	63.5	10/31/2018	58.2
11/1/2018	63.2	11/1/2018	62	11/1/2018	61.5	11/1/2018	55.4
11/2/2018	64.7	11/2/2018	62.4	11/2/2018	63.5	11/2/2018	57.9
11/3/2018	57.9	11/3/2018	57.1	11/3/2018	56.9	11/3/2018	51.6
11/4/2018	55.5	11/4/2018	57.1	11/4/2018	55.5	11/4/2018	49.5
11/5/2018	63.6	11/5/2018	65.5	11/5/2018	65.3	11/5/2018	56.3
11/6/2018	64.4	11/6/2018	66.5	11/6/2018	64.8	11/6/2018	59.5
11/7/2018	64.1	11/7/2018	64.8	11/7/2018	65.6	11/7/2018	59.1
11/8/2018	61.6	11/8/2018	63.7	11/8/2018	63	11/8/2018	57.9
11/9/2018	60.8	11/9/2018	62.9	11/9/2018	62	11/9/2018	54.1
11/10/2018	58.3	11/10/2018	55.8	11/10/2018	56.4	11/10/2018	50.4
11/11/2018	55.2	11/11/2018	55.4	11/11/2018	55.2	11/11/2018	48.6
11/12/2018	55.5	11/12/2018	54.9	11/12/2018	55.5	11/12/2018	49.3
11/13/2018	61.5	11/13/2018	62.3	11/13/2018	60.6	11/13/2018	54
11/14/2018	63.9	11/14/2018	67.1	11/14/2018	62.5	11/14/2018	57.1
11/15/2018	63.6	11/15/2018	65.8	11/15/2018	65.4	11/15/2018	57.2
11/16/2018	62.5	11/16/2018	61.9	11/16/2018	62.5	11/16/2018	55.8
11/17/2018	57.8	11/17/2018	58.5	11/17/2018	58.6	11/17/2018	52.3
11/18/2018	56.1	11/18/2018	56.6	11/18/2018	55.9	11/18/2018	50.6
11/19/2018	65.3	11/19/2018	64.9	11/19/2018	64	11/19/2018	61.1
11/20/2018	65.3	11/20/2018	67.5	11/20/2018	64.8	11/20/2018	61.1
11/21/2018	63.4	11/21/2018	65.3	11/21/2018	62.6	11/21/2018	55.9
11/22/2018	55.3	11/22/2018	54.4	11/22/2018	54.5	11/22/2018	48.5
11/23/2018	56.2	11/23/2018	57.9	11/23/2018	58.6	11/23/2018	48.9
11/24/2018	56.1	11/24/2018	57.6	11/24/2018	58.3	11/24/2018	50.2
11/25/2018	55.5	11/25/2018	55.6	11/25/2018	55.1	11/25/2018	49.2
11/26/2018	63.5	11/26/2018	66.2	11/26/2018	64	11/26/2018	56.8
11/27/2018	62.6	11/27/2018	64.6	11/27/2018	62.9	11/27/2018	55.1
11/28/2018	67.7	11/28/2018	70.6	11/28/2018	67	11/28/2018	65.8
0	0	11/29/2018	65.6	11/29/2018	62	11/29/2018	55.8

Appendix C: Extension Night Data

Extension Night	0	0
Date	LAeq (12Hr)	Laeq 1Hr Max
10/31/2018	55.801624	60.4
11/1/2018	58.526825	67.3
11/2/2018	55.065065	57.3
11/3/2018	55.330106	60.7
11/4/2018	52.887374	54.6
11/5/2018	53.328582	59
11/6/2018	55.007539	59.7
11/7/2018	55.827488	60
11/8/2018	54.967211	60.1
11/9/2018	57.255327	63.1
11/10/2018	52.616477	57
11/11/2018	53.109735	58.6
11/12/2018	52.002749	56
11/13/2018	53.338238	60.7
11/14/2018	55.62729	61.4
11/15/2018	54.001773	60
11/16/2018	55.210761	59.8
11/17/2018	54.470146	57
11/18/2018	52.027459	55
11/19/2018	54.478007	59.9
11/20/2018	55.41283	58.6
11/21/2018	57.887703	63.5
11/22/2018	52.353591	56.2
11/23/2018	51.673767	56.9
11/24/2018	52.404114	57.8
11/25/2018	50.858648	53.5
11/26/2018	54.044943	58.5
11/27/2018	54.741623	57
11/28/2018	60.624324	69.5
11/29/2018	55.305299	58.8