Saint Paul Downtown Airport (STP)
Annual Sound Study Report

October 2022

Community Relations Office

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1.0 Introduction

The Metropolitan Airports Commission (MAC) completed the 2022 STP Annual Sound Study in support of the St. Paul Downtown Airport Advisory Council (DAAC) 2022-2023 Work Plan and Supplemental Conditions of Agreement related to the flood wall erected in 2009. The study involved two industry standard methods for assessing aircraft sound: field-measurement analysis and modeled data.

Field sound measurements were conducted by MAC Community Relations staff using certified equipment and best practices to measure and collect sound data at each of the six field locations. The results of this study are intended to enhance communication about sounds associated with St. Paul Downtown Airport (STP) aircraft activity. As such, field measurements captured aircraft sound events and community sounds events at six locations surrounding STP during a seven-day period: August 18-24, 2022. Sound data that are not correlated to aircraft arriving to or departing from STP are included in this study as community sound events.

Sound level modeling for STP flight activity was performed using the Federal Aviation Administration's (FAA) Aviation Environmental Design Tool (AEDT) modeling software to provide expanded sound data coverage to inform the DAAC and airport stakeholders about aircraft activity and corresponding sound levels for the same seven-day study period.

The sections below describe the STP runway use, aircraft operations, weather, field-measured data collection process and analysis, AEDT modeling data and analysis, a comparison of measured data and modeled data, and a summary of aircraft noise complaints received during the study period.

2.0 Operations

STP is a general aviation, public use airport owned and operated by the MAC. The airport is a primary reliever airport for Minneapolis-St. Paul International Airport (MSP) and accommodates personal use and recreational aircraft, business general aviation and air taxi aircraft, flight training and military aircraft. The aircraft operating at the airport currently include single and multi-engine propeller-driven aircraft, corporate jet aircraft, and helicopters.

The airport is open for aircraft operations 24 hours per day; however, FAA Air Traffic Controllers (ATC) are on site to help direct aircraft operations during the busiest operational periods. ATC directed aircraft into and out of STP between 6:00 AM and 10:00 PM, Monday through Friday and between 7:00 AM and 10:00 PM on Saturday and Sunday during the study period. There are three runways available for use at STP: Runway 14/32, Runway 13/31, and Runway 9/27. Helicopters may land and depart from areas other than a runway.

According to FAA aircraft operations counts for STP during August, the three-year average for 2020, 2021, and 2022 shows 4,153 monthly operations, with 1,038 flights using the airport during an average week when the Air Traffic Control Tower is staffed. The three-year average is impacted by reduced operational levels at STP in 2020 as a result of the impacts of COVID-19; operational levels were only 50 percent of typical levels that historically occur in August at the airport in 2020. In August 2022, higher than typical levels were reported by the FAA due to increased flight training; there were 5,999 STP flight operations, with 1,657 operations occurring during the study period. The increased level of flight training during the study period

was likely at least in part due to a runway closure at South Saint Paul Airport (SGS) due to construction. Many aircraft that would typically utilize SGS operated at STP instead during the study period.

Flight training at STP generates multiple operations during a single flight as pilots practice their takeoffs and landings (called touch and go operations) for proficiency. It is normal and expected that the airport will be busier in the summer with increased flight training and recreational flying. The STP Sound Study is performed during this time of year to capture as much aircraft activity data as possible.

The MAC Noise and Operations Monitoring System (MACNOMS) collects flight tracking data and reports operations data. Until recently, MACNOMS counted an operation only when a flight arrived at the airport or departed from the airport. This means that a single training flight that included numerous consecutive takeoffs and landings would only be counted for its initial takeoff and its final landing. Beginning on July 1, 2021, the MACNOMS methodology for counting operations was updated to more accurately reflect total aircraft departures or arrivals at MAC airports. The updated methodology was used for 2022 operations counts, while historical data reflect prior methodology. While the process for counting MACNOMS operations has improved, discrepancies remain between FAA reported operations and MACNOMS.

During the study period, MACNOMS data show 1,544 total operations at STP with 772 arrivals and 772 departures. Table 2.1 shows the number of operations on each STP runway per day. The highest levels of STP runway use occurred on Runway 14 with 358 arrivals and 361 departures.

Table 2.1: STP Aircraft Activity per Runway each Day during the Study Period

Runway	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	23-Aug	24-Aug	**Runway Total**
STP Arrivals								
9	-	-	13	3	2	-	-	18
13	3	1	4	-	-	1	3	12
14	51	74	3	30	74	116	139	487
27	1	1	2	1	-	1	-	6
31	-	-	8	9	7	-	-	24
32	27	2	77	53	57	2	6	224
Blank	-	-	-	-	-	-	1	1
STP Departures								
9	2	1	1	5	2	2	-	13
13	3	-	-	4	-	1	4	12
14	49	79	4	30	61	108	151	482
27	1	-	-	-	-	-	-	1
31	-	-	9	1	3	-	-	13
32	27	-	92	51	72	3	6	251
Daily Total	**164**	**158**	**213**	**187**	**278**	**234**	**310**	**1,544**

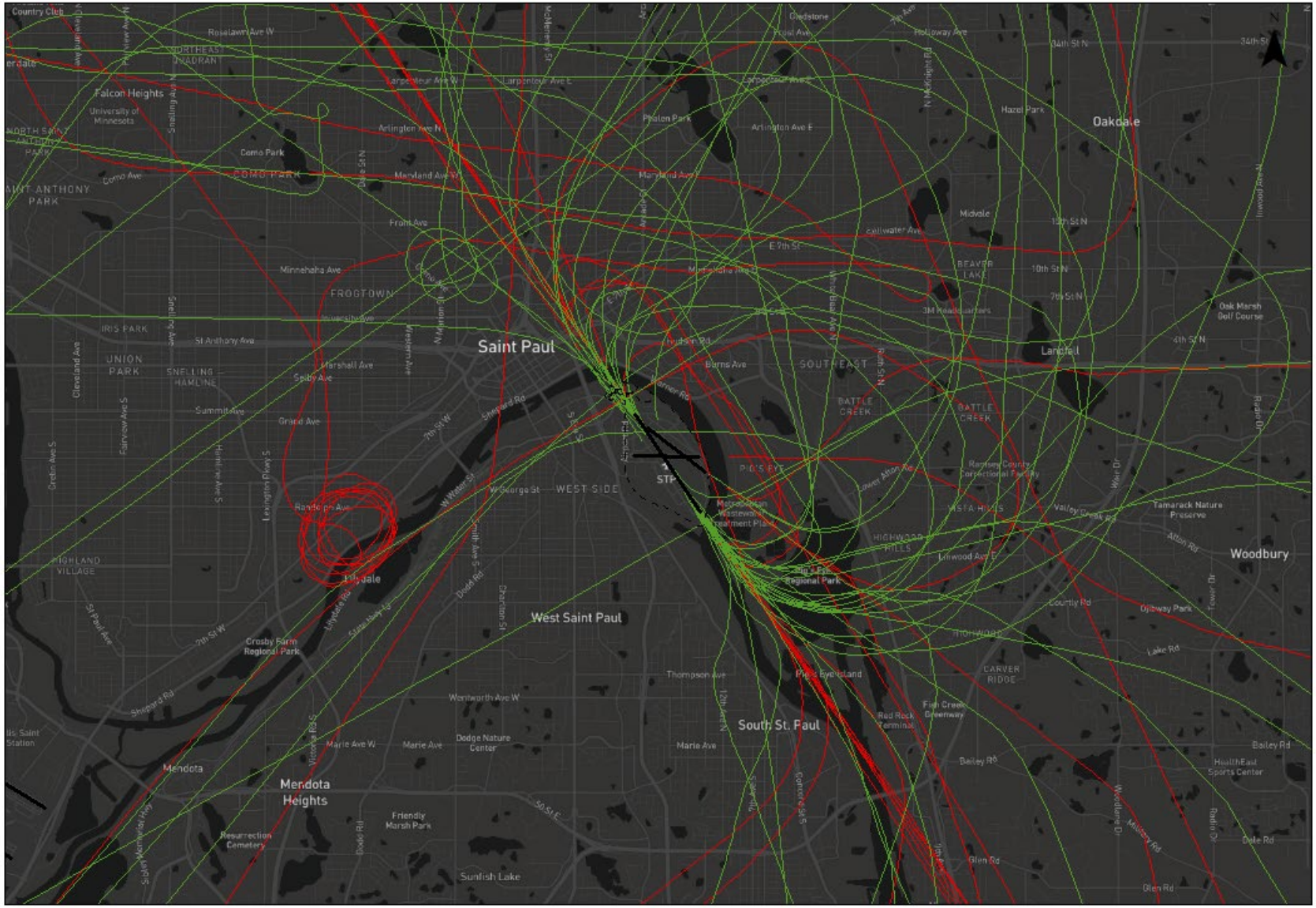
Runway 14/32 was used for 94 percent of the activity during the study period, Runway 13/31 was used 4 percent and Runway 9/27 was used 2 percent. Figure 2.1 shows the STP flight tracks for daytime operations.

There were 75 flights that operated between the hours of 10:00 P.M. and 7:00 A.M.; of those flights 31 were arrivals and 44 were departures. Figures 2.2 depicts STP nighttime activity during the study period.

Weather during the study week was desirable for flying with typical mid-summer wind and temperature patterns, and very little precipitation occurred. Weather conditions (e.g., temperature, precipitation, wind, etc.) affect airport activity, runway use decisions and aircraft performance. In addition to operational factors, weather conditions can also affect the way sound is transmitted and observed. As such, weather data are documented during the study period and a summary of daily weather conditions is available in the Appendix.

Figure 2.1: STP Daytime (7:00 A.M to 10:00 P.M.) Operations During Study Period

Figure 2.2: STP Nighttime (10:00 PM to 7:00 AM) Operations During Study Period



3.0 Field-Measured Sound Data

An STP Annual Sound Study, assessing field-measured sound data, has been conducted since 2007. The MAC has completed the annual study in accordance with Supplemental Conditions of Agreement (MAC action taken on June 19, 2006) related to the flood protection project at STP. A core element of the flood protection plan was the construction of the flood wall at STP in 2009 to mitigate flood events that historically have required the airport close. A copy of the Supplemental Conditions is provided in the Appendix.

Since 2007, six field measurement sites have been positioned in coordination with DAAC District Council memberships, and consistent with MAC Mobile Sound Monitoring Guidelines. These guidelines, and a map of all Saint Paul Districts are provided in the Appendix.

Field measurement sites are positioned in the same or similar locations each year as much as possible to assist with comparing results. In 2022, five of the six sites were positioned in the same locations as the 2021 study. One location, site 3, was moved from a resident backyard to the community garden about 1,000 feet away.

The dates of this study period are August 18-24, 2022. This general time frame was coordinated with the DAAC during its meeting on April 19, 2022. Figure 3.1 shows a map of the field measurement equipment locations, and Figure 3.2 shows a picture of each field measurement site.

3.2 Field Measurement Analysis and Parameters

One sound analyzer collected data at each of the field-measurement sites. Each site operated continuously measuring sound levels utilizing a slow response with A-weighting (dBA), as federally-prescribed by standards for collecting aircraft sounds in the FAA's 14 CFR Part 150. Sound events are identified and documented when the sound level exceeds 65 dBA for four seconds or longer. The parameters used by the sound monitoring instrumentation measure both community and aircraft sounds. The equipment and tolerances are set to be sensitive so that aircraft do not have to fly directly over the measurement site to be recorded.

In this study, sound events from aircraft and community sound sources were detected. Sound events were correlated with STP flight track data, collected by MACNOMS, using temporal and spatial parameters (time and distance). All uncorrelated sound events are referred to in this report as community events.

Figure 3.1: Field Measurement Equipment Locations

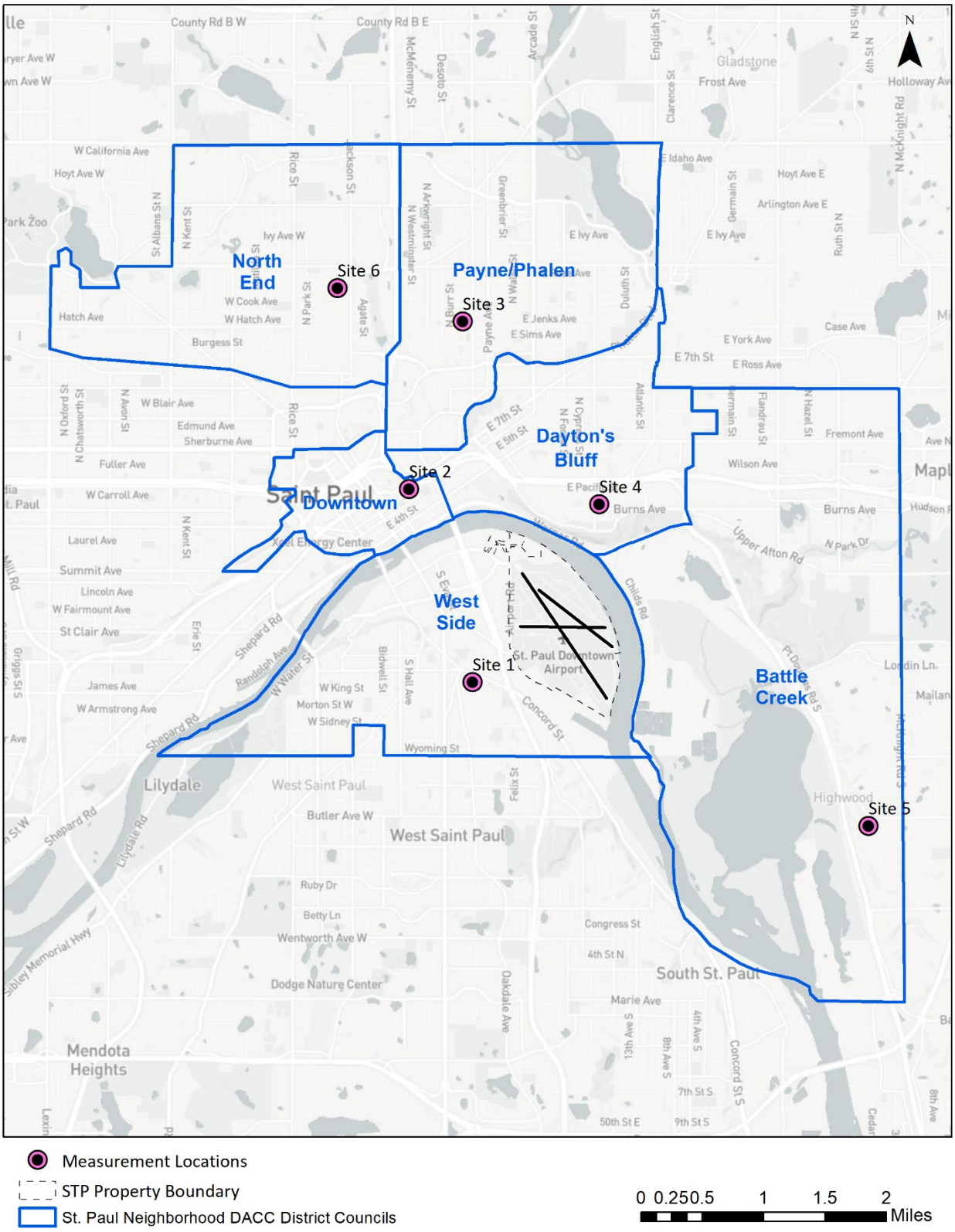


Figure 3.2: Field-Measurement Site Photos

3.3 Field Measurement Results

There were 350 aircraft sound events and 931 community sound events measured at the six sites during the seven-day study period. This section summarizes information for both aircraft and community sound sources described in terms of sound event metrics (LA_{max}, SEL, Event Duration) and summary-based metrics (DNL, ADNL, CDNL and LA_{90}).

Single Sound Events Metrics

Table 3.1 shows the daily number of single aircraft sound events aircraft sounds that exceeded 65 dBA for four seconds. The largest number of aircraft sound events captured during the study period on a daily basis occurred on Saturday, August 20 with 61 events. The smallest number of aircraft sound events measured during the study period occurred on Friday, August 19 with 38 events.

Table 3.1 also shows a total number of sound events captures for each site. Site 6 measured the most aircraft sound events during the study period with 93 events. The second-highest number of aircraft sound events was 63 events at Site 2. Both sites measured aircraft using Runway 14/32, which is the most-heavily used runway during the study period. More detail about runway use was provided in Section 2.0.

Table 3.1: Number of Measured STP Aircraft Sound Events per Day

	Thur. August 18	Fri. August 19	Sat. August 20	Sun. August 21	Mon. August 22	Tue. August 23	Wed. August 24	Site Total
Site 1	9	4	9	4	5	1	6	38
Site 2	8	3	19	11	9	6	7	63
Site 3	12	3	5	11	13	5	4	53
Site 4	4	--	22	7	10	4	5	52
Site 5	9	11	2	4	6	7	12	51
Site 6	15	17	4	10	10	24	13	93
Daily Total	57	38	61	47	53	47	47	350

Figure 3.3 shows the number of aircraft sound events that were measured each hour during the study period. The highest number of aircraft sounds were captured during the 1:00 P.M., 2:00 P.M., and 3:00 P.M. hours with 37, 33, and 36 measured aircraft sound events, respectively. Site 6 measured the highest number of aircraft sound events during a one-hour period with 14 events in the 3:00 P.M. hour. There were 43 aircraft sound events measured during the nighttime hours of 10:00 P.M. – 7:00 A.M.

Table 3.2, below, shows the number of measured aircraft arrival and departure sound events with LA_{max} levels at or above 65 dBA, 80 dBA, 90 dBA, and 100 dBA at each site. A total of 350 aircraft sound events were measured at or above 65 dBA. Of those, 11 events were at or above 80 dBA and one was at or above 90 dBA. The loudest sound event was 90.1 dB generated by the commemorative B-25 aircraft known as Miss Mitchell, departing on STP Runway 32 on 8/18/2022 at 12:06 P.M.

The highest number of arrival sound events was 80, measured at Site 6. The highest number of departure sound events was 40 measured at Site 5.

Figure 3.3: Number of STP Aircraft Sound Events Above 65 dBA per Hour by Site

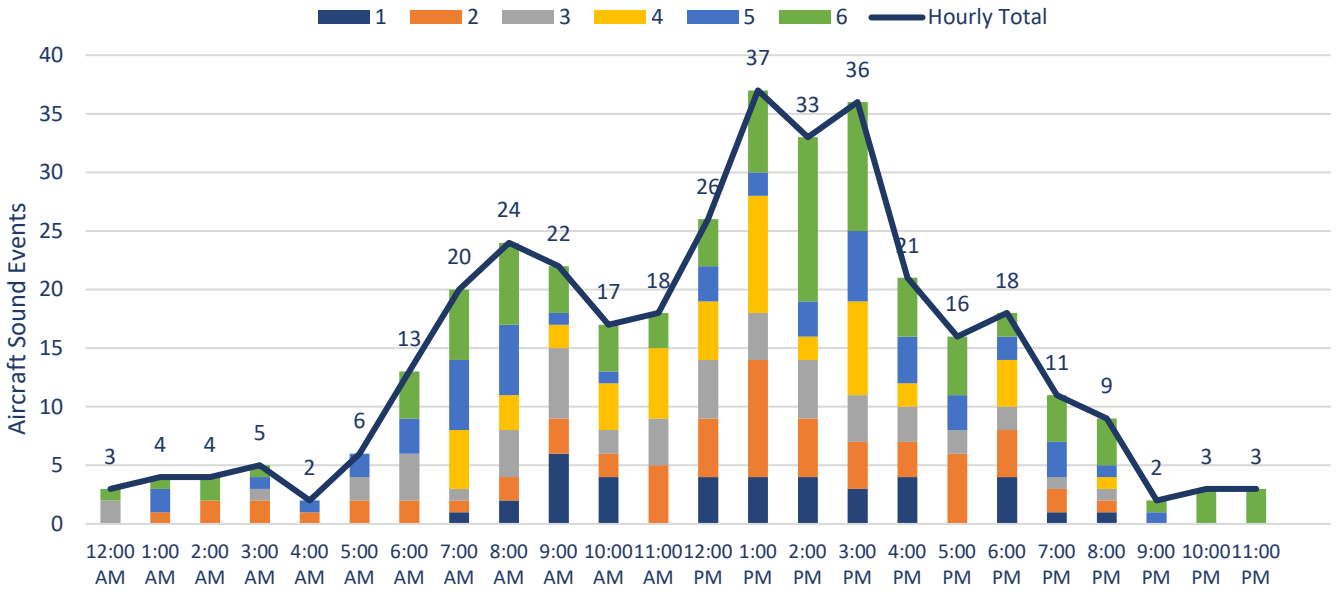
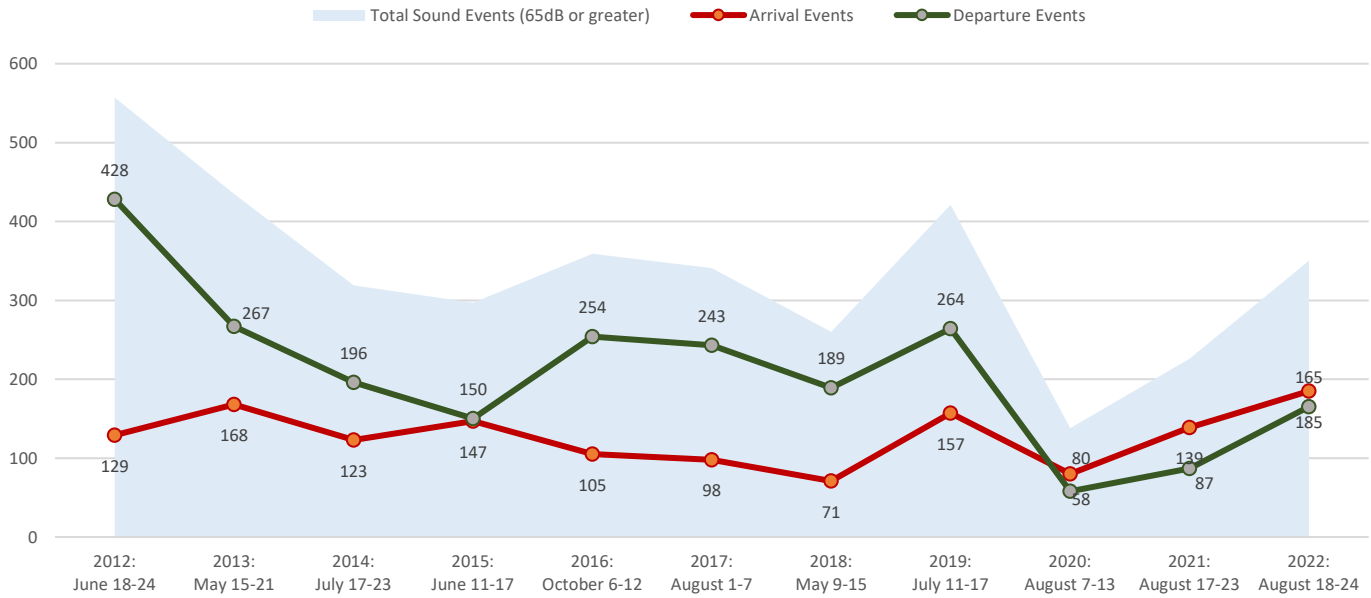


Table 3.2: Number of Measured STP Aircraft Sound Events by Level (LA_{max})				
Site	# of Events > 65dBA	# of Events > 80dBA	# of Events > 90dBA	# of Events > 100dBA
Aircraft Arrivals				
1	23	0	0	0
2	25	1	0	0
3	22	0	0	0
4	24	2	0	0
5	11	1	0	0
6	80	4	0	0
Arrival Total	185	8	0	0
Aircraft Departures				
1	15	0	0	0
2	38	1	0	0
3	31	2	1	0
4	28	0	0	0
5	40	0	0	0
6	13	0	0	0
Departure Total	165	3	1	0
Total Aircraft Events	350	11	1	0

Sound events measured during each study period between 2012 and 2022 are shown in Figure 3.4. This is provided for historical reference. Trends should not be inferred due to variations in study parameters.

Figure 3.4 Sound Event Totals Measured during Study Periods in 2012 – 2022



Sound events cannot be directly compared without normalization due to variations in sound levels and durations. The Sound Exposure Level (SEL) is a metric that provides a way to directly compare each event by expressing the sound energy of that event as a single second (1s) value, regardless of the actual event duration. The SEL and LA_{max} are not the same and in many cases and they rank differently.

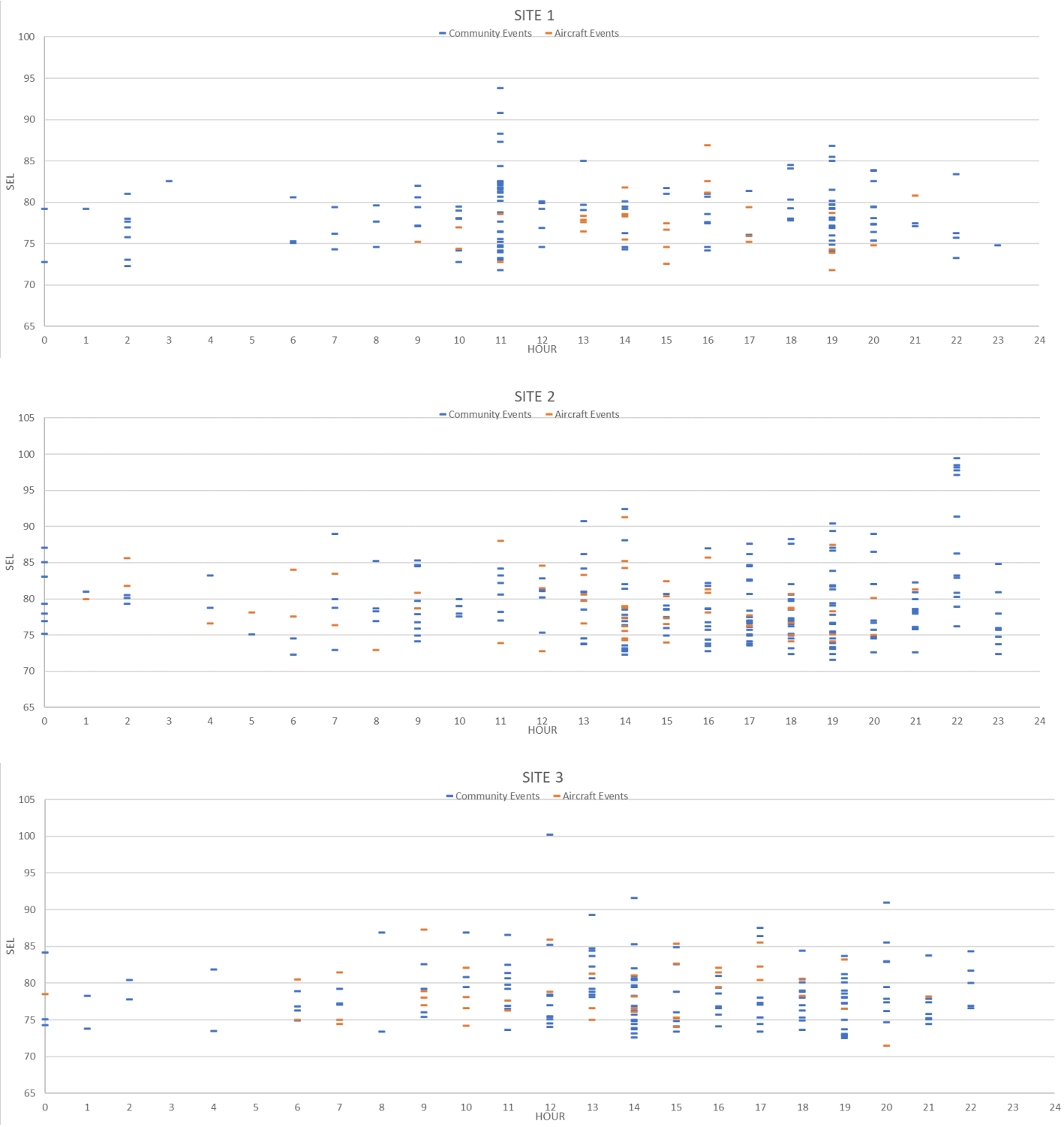
Figure 3.5 shows the measured hourly aircraft and community SEL events for each site.

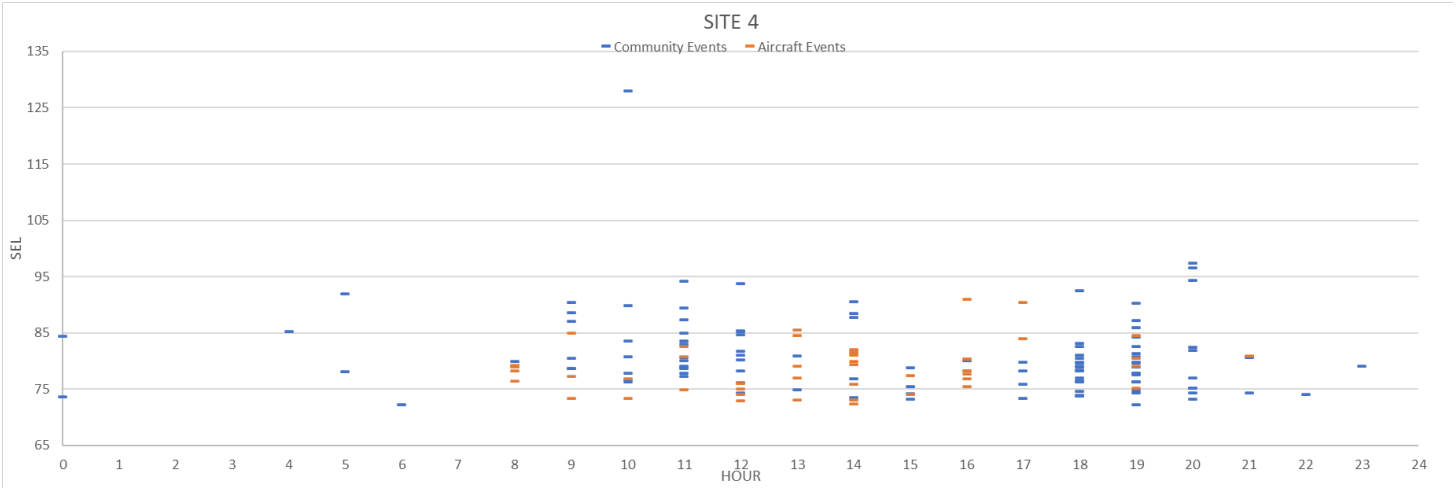
Sites 1 and 5 measured the highest SEL community events, and the highest SEL aircraft events occurred at Site 2 and Site 6. Table 3.3 shows the types of aircraft associated with highest LA_{max} at each site during the study period, ranked by LA_{max}. The SEL ranking is also included for each of these operations however, the SEL ranking may not be consistent with the LA_{max} rankings. Because SEL compresses all the energy of the event into one second, a short event will have a lower SEL than a longer event even if the two events have similar similar LA_{max}, generally speaking. As such, the LA_{max} and SEL rankings may not be the same.

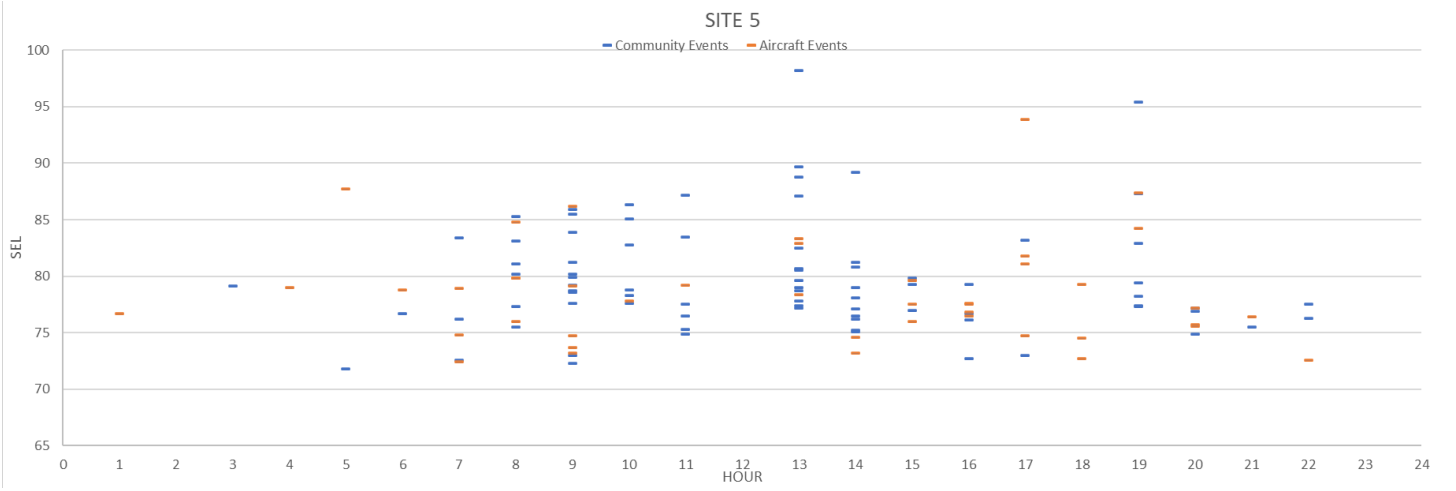
The aircraft sound event with the longest duration was measured at 41 seconds and occurred at Site 4 by the commemorative B-25, Miss Mitchell, aircraft on August 20 at 5:02 P.M. with a LA_{max} of 81.8 dB and a SEL of 90.4.

The loudest aircraft sound event during the study period occurred at Site 3 by the commemorative B-25, Miss Mitchell, aircraft measuring a maximum level at 90.1 dBA on August 18 at 12:06 P.M. The SEL for this aircraft sound event measured at 96.1.

Figure 3.5: Aircraft and Community Sound Events per Hour (SEL)




SITE 4
Community Events
Aircraft Events
SEL
HOUR


SITE 5
Community Events
Aircraft Events
SEL
HOUR

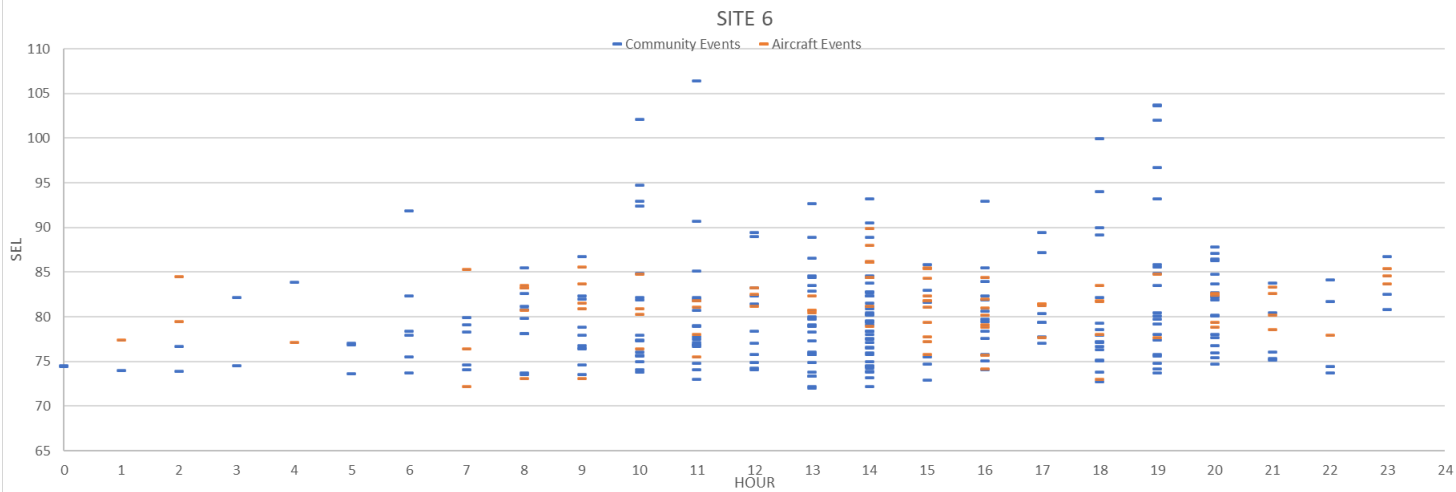

SITE 6
Community Events
Aircraft Events
SEL
HOUR

Table 3.3 Top-Ten Measured STP Aircraft Sound Events per Site

Site 1- District 3 (Mt. Hope Dr)							
Date and Time	LA_{max}	Duration	SEL	Aircraft Type	Flight ID	Rank LA_{max}	Rank SEL
8/18/2022 17:43	77.8	23	87.2	PA28	N9341C	1	1
8/21/2022 16:25	77	25	86.9	B25	N27493	2	2
8/18/2022 10:53	75.5	19	84.3	C172	N262TA	3	3
8/18/2022 8:45	75.1	8	80.5	PA32	N55679	4	9
8/24/2022 16:13	74.1	11	81.2	BE95	N102FA	5	7
8/18/2022 9:52	73.2	16	82.2	P28R	N9659K	6	5
8/20/2022 14:07	73.1	17	81.8	UKN	Unknown	7	6
8/22/2022 21:54	72.4	12	80.8	PA28	N9341C	8	8
8/23/2022 15:31	72.3	5	77.5	KODI	N45DV	9	19
8/24/2022 17:04	72.3	9	79.4	C208	N208WF	10	10

Site 2- District 17 (Allen Building)							
Date and Time	LA_{max}	Duration	SEL	Aircraft Type	Flight ID	Rank LA_{max}	Rank SEL
8/23/2022 14:29	83.2	22	91.3	B407	N118SP	1	1
8/24/2022 11:39	81.3	17	88	BE95	N102FA	2	2
8/18/2022 12:05	78.1	22	85.7	B25	N27493	3	5
8/21/2022 16:16	78	28	85.7	STL5	N68591	4	4
8/18/2022 19:44	77.7	23	87.5	BE40	N387LS	5	3
8/22/2022 14:53	76.7	18	85.2	BE95	N102FA	6	7
8/21/2022 2:03	76.5	22	85.6	C550	N121HL	7	6
8/24/2022 12:49	75.1	25	84.6	PA28	N41357	8	8
8/23/2022 16:26	74.9	9	80.8	BE95	N102FA	9	20
8/22/2022 7:56	74.7	16	83.5	E55P	N505GP	10	11

Site 3- District 5 (Jenks Av)							
Date and Time	LA_{max}	Duration	SEL	Aircraft Type	Flight ID	Rank LA_{max}	Rank SEL
8/18/2022 12:06	90.1	22	96.1	B25	N27493	1	1
8/18/2022 13:41	84.3	17	90.7	C172	N51840	2	2
8/18/2022 12:35	79.1	17	87.4	BA146	TNKR18	3	3
8/18/2022 10:16	78.2	12	84.3	E55P	N996SC	4	8
8/20/2022 15:09	77.3	15	85.4	GLF5	N899NC	5	7
8/19/2022 12:31	76.9	18	85.9	PC12	N98GX	6	5
8/22/2022 17:19	76.9	16	85.5	PC12	N98GX	7	6
8/21/2022 9:09	76.3	24	87.3	B25	N27493	8	4
8/22/2022 16:21	74.8	12	82.1	C560	N560AW	9	13
8/21/2022 15:11	74.6	12	82.7	C650	N28TX	10	11

Site 4- District 4 (Suburban Av)							
Date and Time	LA_{max}	Duration	SEL	Aircraft Type	Flight ID	Rank LA_{max}	Rank SEL
8/21/2022 16:27	83.7	16	90.9	B25	N27493	1	1
8/20/2022 17:02	81.8	41	90.4	B25	N27493	2	2
8/20/2022 13:53	77.8	11	84.6	R44	N854WS	3	5
8/20/2022 19:36	77.4	14	84.5	PA28	N32004	4	6
8/22/2022 9:42	76.9	14	85	PA28	N9341C	5	4
8/21/2022 17:19	76.2	14	84	PA28	N9341C	6	7
8/21/2022 13:18	76.1	16	85.5	P28R	N9659K	7	3
8/20/2022 11:24	75.7	11	82.6	COL3	N6500G	8	8
8/23/2022 16:25	75	8	80.3	BE95	N102FA	9	19
8/20/2022 14:48	74.3	11	81.6	C172	N739GG	10	10

Site 5- District 1 (Skyway Dr)							
Date and Time	LA_{max}	Duration	SEL	Aircraft Type	Flight ID	Rank LA_{max}	Rank SEL
8/20/2022 17:03	87.6	23	93.9	B25	N27493	1	1
8/18/2022 16:17	79.7	17	87.1	C650	N949SA	2	4
8/18/2022 6:32	78.9	15	85.7	CL30	DOW896	3	6
8/19/2022 5:20	78.4	19	87.7	FA50	DOW828	4	2
8/22/2022 19:20	78.4	21	87.4	BE40	N902RY	5	3
8/19/2022 8:57	78.1	10	84.8	F2TH	N353V	6	7
8/24/2022 19:24	77.1	14	84.2	CL30	N165RD	7	8
8/19/2022 9:28	77	21	86.2	BE40	N478DR	8	5
8/24/2022 13:37	77	8	82.9	F2TH	N132M	9	10
8/24/2022 13:55	75.6	19	83.3	GLF4	PEG89	10	9

Site 6- District 6 (Abell Dr)							
Date and Time	LA_{max}	Duration	SEL	Aircraft Type	Flight ID	Rank LA_{max}	Rank SEL
8/19/2022 14:09	81.5	10	86.2	BE9L	N55MN	1	4
8/18/2022 0:12	81.4	15	88.8	BE20	LN901BA	2	2
8/23/2022 15:34	80.7	10	85.4	BE9L	N55MN	3	8
8/24/2022 14:08	80.7	20	89.9	UKN		4	1
8/23/2022 14:33	79.2	22	88	B412	CFC0543	5	3
8/19/2022 15:08	78.7	13	85.5	C56X	N524BB	6	7
8/19/2022 14:26	78.7	14	86.1	GLF5	N899NC	7	5
8/24/2022 7:28	78.6	12	85.3	C56X	N524BB	8	10
8/20/2022 19:05	78.3	13	84.8	UKN	Unknown	9	11
8/18/2022 18:28	78	11	83.5	C56X	EJA609	10	21

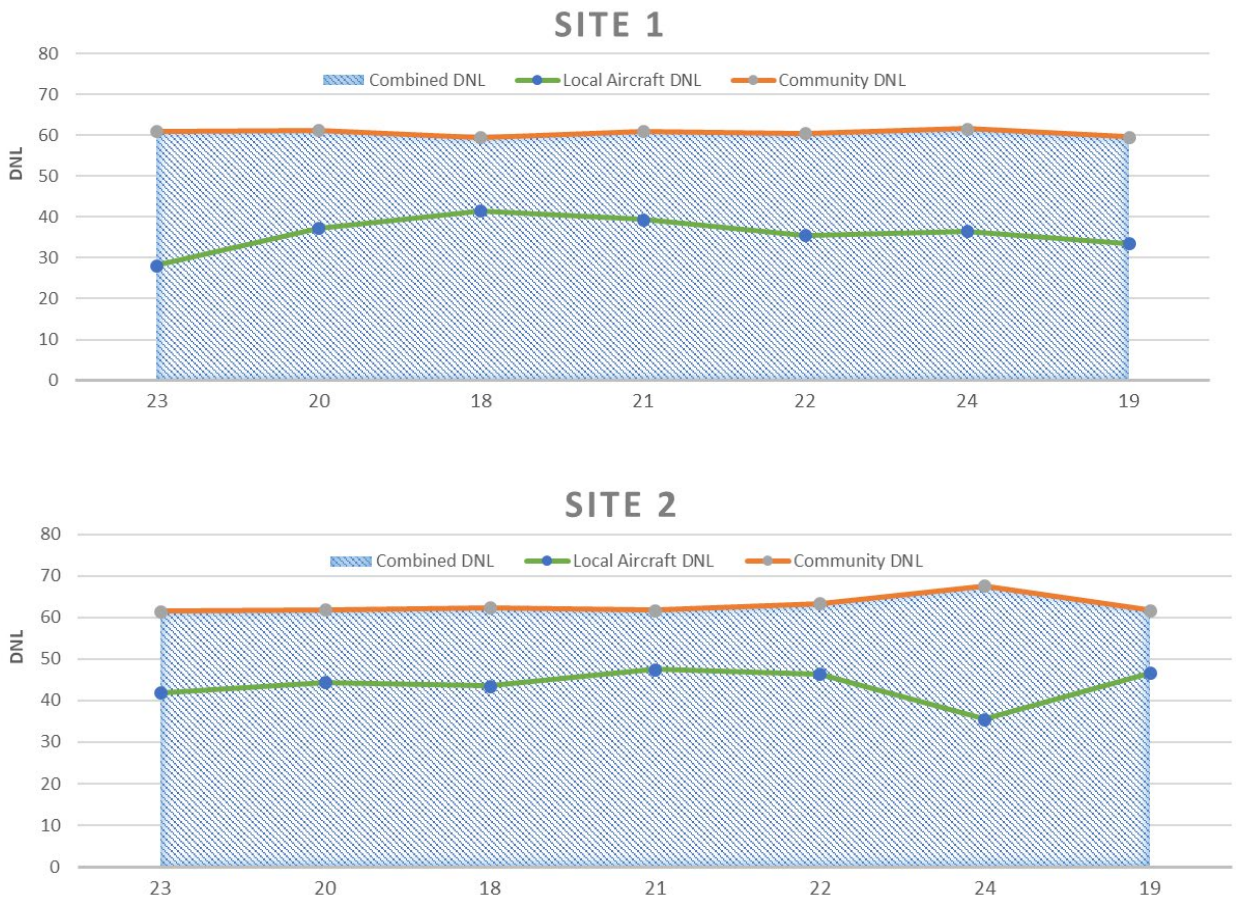
Summary Based Metrics

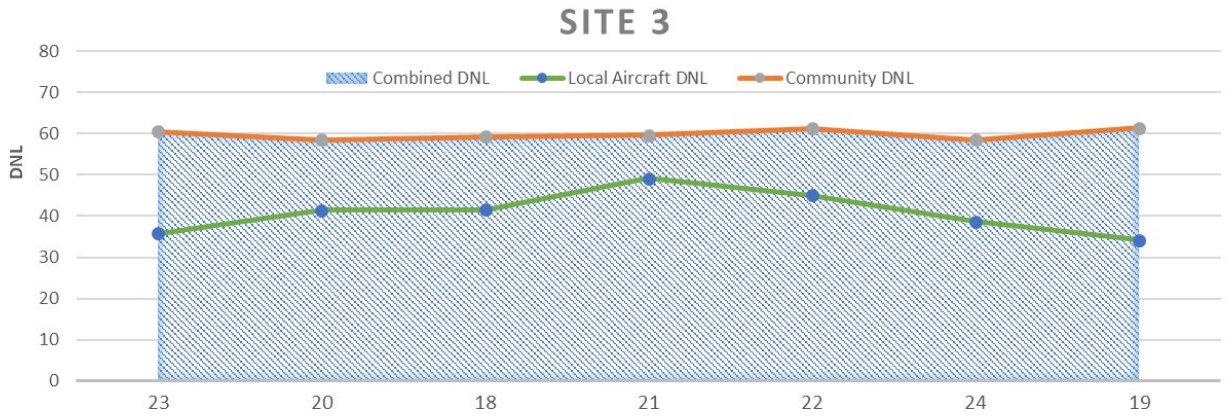
Day-Night Average sound level (DNL) is an acoustic, summary-based metric that represents the total accumulation of all sound energy during a 24-hour day, including a 10 dB penalty applied to all sounds between 10:00 P.M. and 7:00 A.M. The FAA prescribes the use of DNL to establish sound exposure and uses a federal threshold of significance of 65 dB DNL. The MAC distinguishes between aircraft and community sounds using Aircraft DNL (ADNL) and Community DNL (CDNL) respectively.

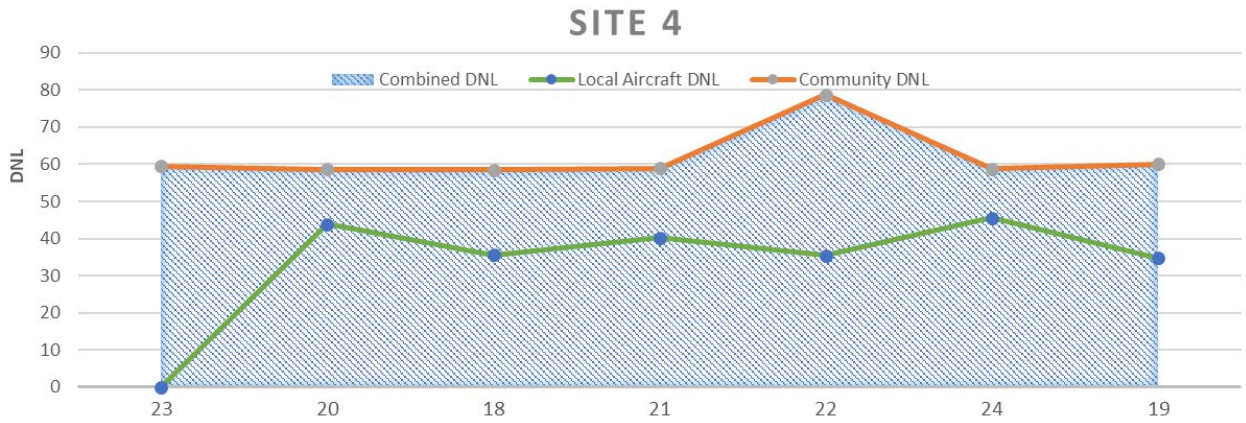
Figure 3.6 shows the ADNL and CDNL accumulations during the study period for each site. The highest ADNL occurred at Site 6 with 51.3 dB DNL on August 18, which is below the federal threshold of significance. The CDNL at Site 6 on the same date was 62.7 dB DNL and the combined DNL was 63 dB DNL.

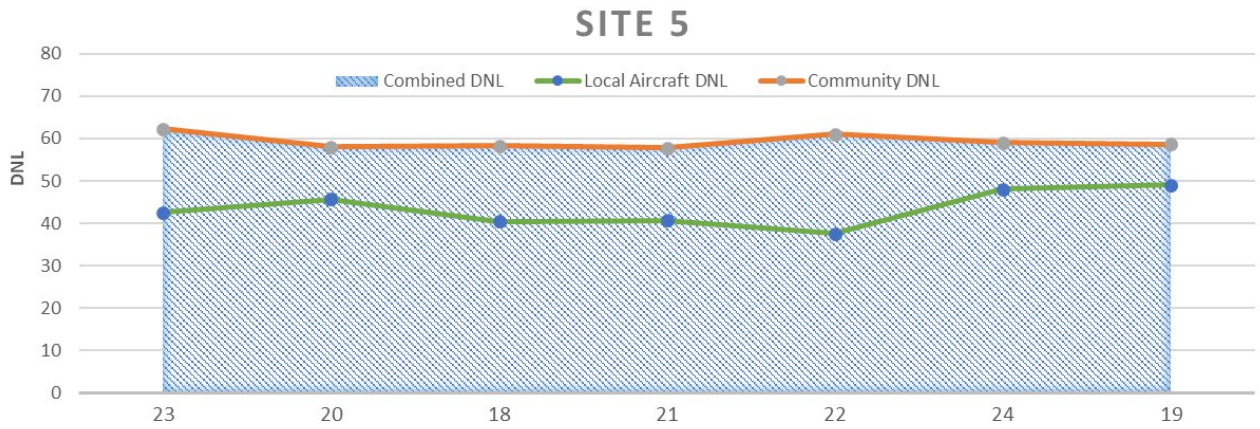
The highest combined DNL occurred at Site 4 on August 24 and was 78.7 dB DNL. The CDNL of 78.7 and the ADNL of 35.4 dB DNL on this date contributed to this high level combined DNL. More detail about field-measured DNL can be found in the Appendix.

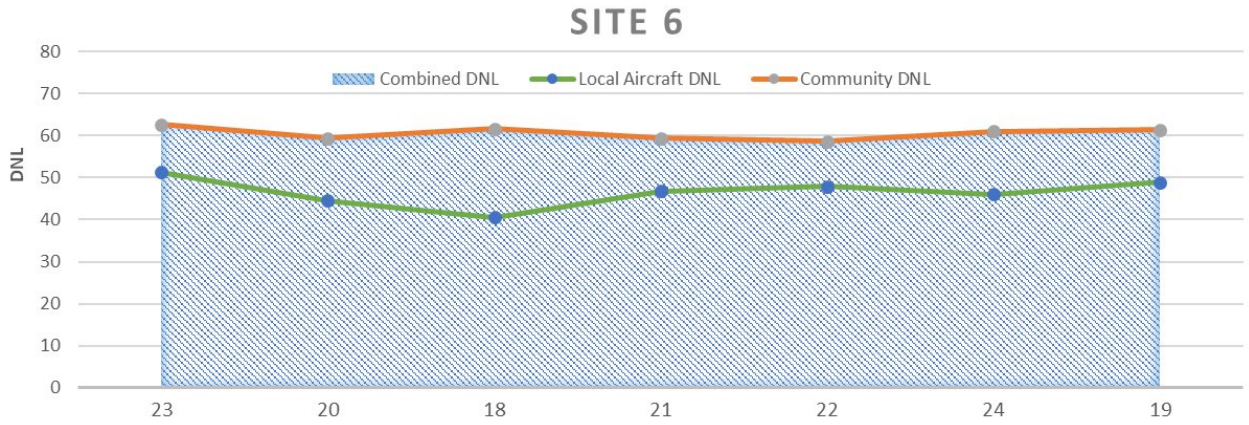
Figure 3.6: Aircraft and Community DNL Accumulations




SITE 3
Combined DNL
Local Aircraft DNL
Community DNL
DNL
80
70
60
50
40
30
20
10
0
23
20
18
21
22
24
19


SITE 4
Combined DNL
Local Aircraft DNL
Community DNL
DNL
90
80
70
60
50
40
30
20
10
0
23
20
18
21
22
24
19


SITE 5
Combined DNL
Local Aircraft DNL
Community DNL
DNL
80
70
60
50
40
30
20
10
0
23
20
18
21
22
24
19



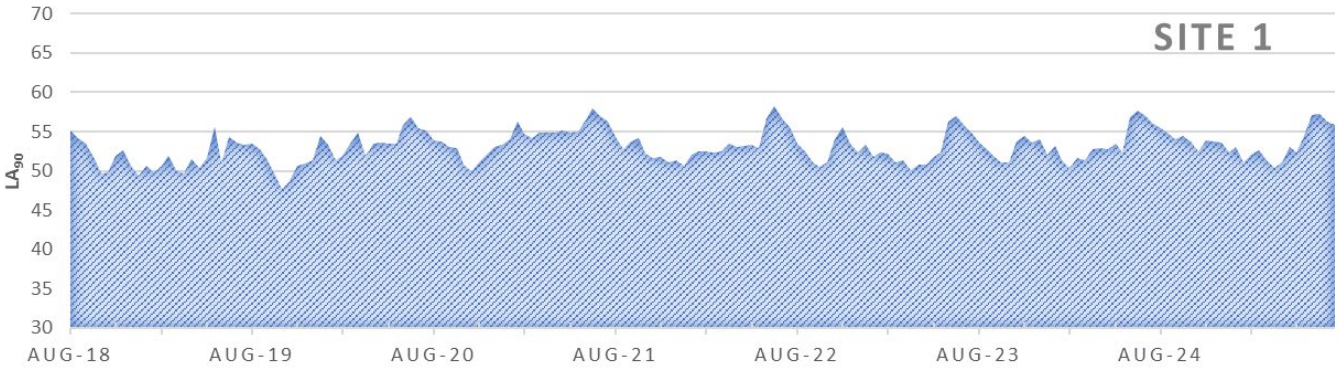
Ambient Sound Levels

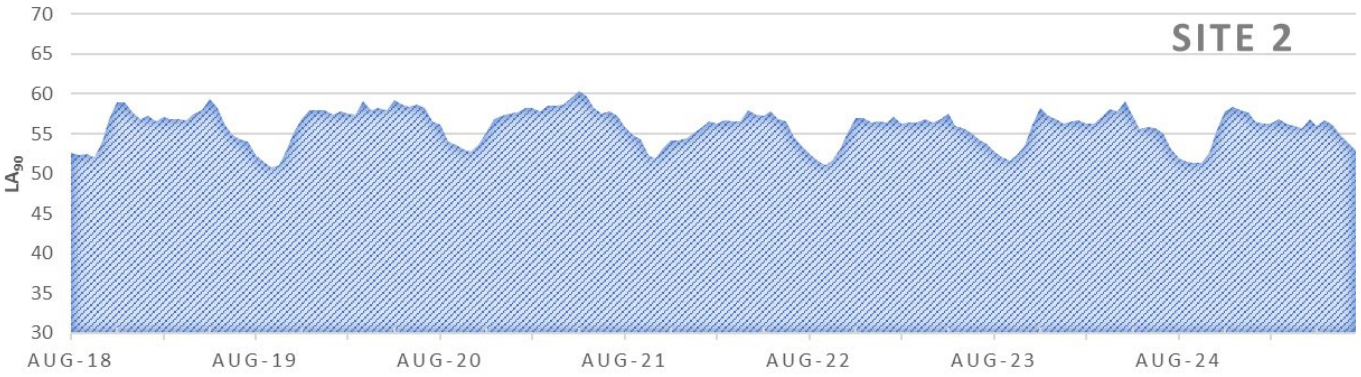
Ambient sounds are continuous; emitted around us by sources we cannot always see, such as wind, mechanical equipment, insects, freeways, etc. Many factors contribute to ambient sound levels (both intensity and frequency) and include natural and human made sounds. Sound events can be transient and/or cyclical (day/night, morning/afternoon/evening/night, weeks, months, seasons, holidays, etc.). Ambient sound levels are important when observing and comparing sound sources to achieve objectivity.

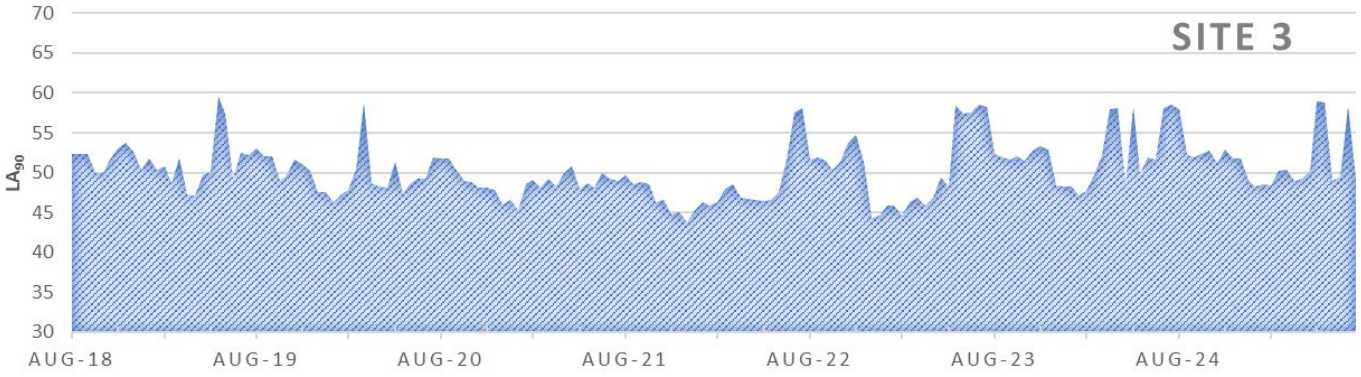
A common method to estimate ambient sound level is to use a statistical metric called the LA_{90}, which is the A-Weighted sound level that is exceeded 90 percent of the time. Figure 3.7 shows the LA_{90} levels measured at each site during the study period.

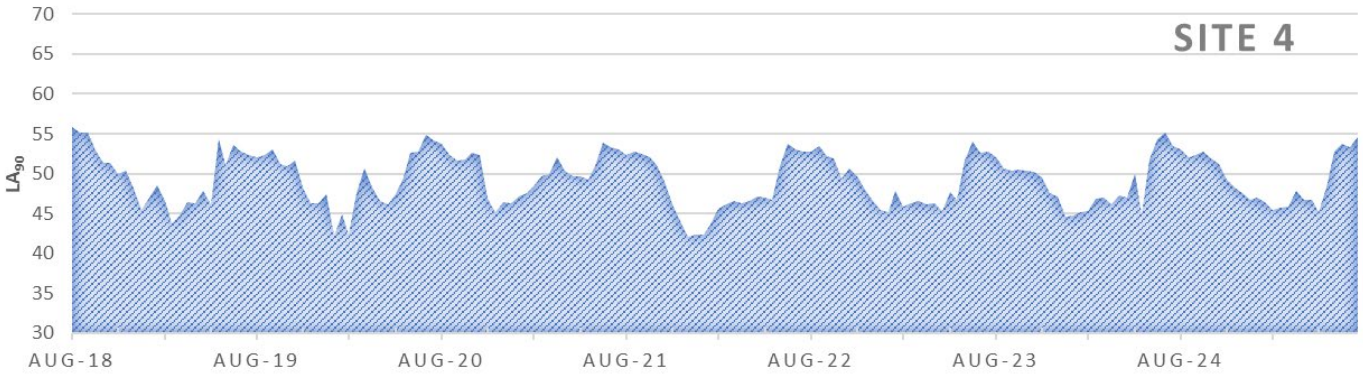
The LA_{90} levels were highest in the vicinity of Site 2 on August 10 with 63.7 dB during the 6 A.M. hour and 63.4 dB during the 1:00 P.M. hour. Site 2 also had an LA_{90} level of 63.4 dB on August 12 during the 5 P.M. hour. As represented by valleys in the charts below, nighttime ambient sound levels are typically lower. Because Site 2 is located in the downtown St. Paul urban area, the ambient sound levels recorded at this location make sense.

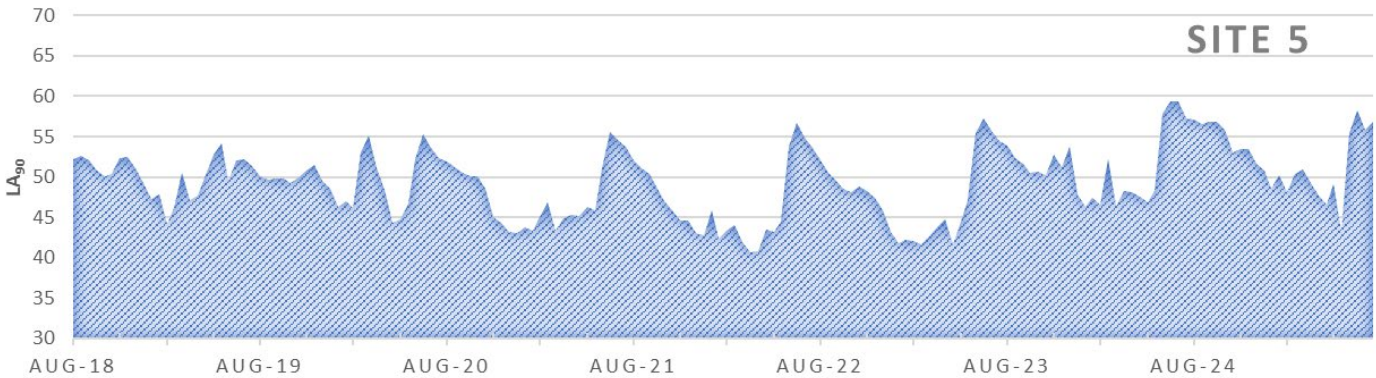
Figure 3.7: Hourly Average Ambient Sound Levels

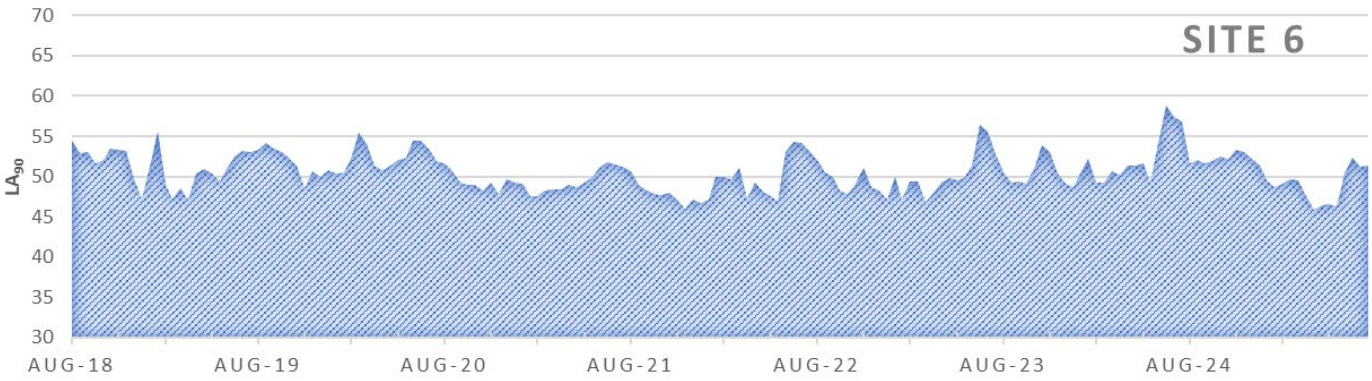



SITE 2
70
65
60
55
50
45
40
35
30
LA90
AUG-18
AUG-19
AUG-20
AUG-21
AUG-22
AUG-23
AUG-24


SITE 3
70
65
60
55
50
45
40
35
30
LA90
AUG-18
AUG-19
AUG-20
AUG-21
AUG-22
AUG-23
AUG-24


SITE 4
70
65
60
55
50
45
40
35
30
LA90
AUG-18
AUG-19
AUG-20
AUG-21
AUG-22
AUG-23
AUG-24


SITE 5
70
65
60
55
50
45
40
35
30
LA90
AUG-18
AUG-19
AUG-20
AUG-21
AUG-22
AUG-23
AUG-24



4.0 Sound Modeling

In addition to field monitoring, STP aircraft activity from August 18-24, 2022 was modeled using the FAA's modeling tool, AEDT, Version 3e. The FAA notes in a recent report to Congress,

> "… while the DNL metric is FAA's decision-making metric, other supplementary metrics can be used to support further disclosure and aid in the public understanding of community noise effects."

With actual monitoring, as noted above, events are documented when the analyzer detects a sound level over 65 dBA for four seconds or longer. Due to the nature of environmental monitoring, MACNOMS must take measures to attempt to filter out community and other ambient sounds before assigning aircraft sound events to a specific operation. The AEDT model does not have community ambient sounds to consider.

Conversely, AEDT must make assumptions about aircraft performance, flap configurations, engine settings, aircraft model types, weight, and weather. AEDT uses standard aircraft thrust settings, standard departure climb-rates as well as standard arrival descent rates, which may not represent actual flight operating characteristics. Additionally, certificated sound data are available for many aircraft types in the model, however all aircraft operating at STP are not represented. In those situations, modeling requires aircraft substitutions be used to represent missing aircraft types.

The goal of conducting field measurement studies and producing modeling results are similar and will often time produce the same sound metric results; however, differences between field measurements and sound modeling will result in variances between the data due to community sounds, measurement parameters, and necessary model assumptions.

The AEDT model can produce various sounds metrics. Two metric options available are the Number Above Noise Level and Time Above Noise Level. For this analysis, MAC staff evaluated the number of operations at or above 65 dB at a specific grid point and their duration.

This modeled sound analysis depicts aircraft sound events from actual aircraft activity at STP from August 18, 2022 through August 24, 2022 using model inputs such as runway use, aircraft fleet mix, aircraft performance and thrust settings, topography, and atmospheric conditions. Quantifying aircraft-specific sound characteristics in AEDT is accomplished using a comprehensive database developed by the FAA under 14 CFR Part 36. As part of the airworthiness certification process, aircraft manufacturers are required to

subject aircraft to a battery of sound tests. Using federally-adopted and endorsed algorithms, this aircraft-specific sound information is used in the generation of model outputs. Justification for such an approach is rooted in national standardization of sound quantification at airports. Appendix A.4 includes the fleet mix and Appendix A.5 includes weather data utilized in the AEDT model for this analysis.

AEDT uses a grid pattern of individual noise measurement points, known as receptors, and calculates sound at each of these points. The grid pattern for this study included 22,500 unique points spaced 0.1 nautical miles apart for a range of 15 miles.

Additionally, AEDT uses standard weather inputs that are typically available for a study comprising a full year of data. For this study, standard weather inputs were changed to represent the average weather conditions for the study period. These inputs are available in Appendix A.5, Table A.1.

Figure 4.1 shows the modeled grid points by average number of events per day during the study period. Grid points with the highest number of events per day are all located within airport property.

Table 4.1 below provides the total number of aircraft sound events above 65 dBA modeled to occur at a field measurement location during the STP study period. The table also provides the number of measured sounds events above 65 dBA correlated to aircraft during the study period for comparison.

Table 4.1 Measured Vs Modeled Number Above Sound Levels

Site	N^{65} Measured	N^{65} Modeled	Difference
1	38	100	62
2	63	134	71
3	53	77	24
4	52	59	7
5	51	107	56
6	93	117	24

Figure 4.2 shows the modeled grid points by average time spent above 65 dBA per day during the study period.

Table 4.2 below provides the total amount of time aircraft sound levels were above 65 dBA modeled to occur at a measurement location during the study period. The table also provides the total monitored time above 65 dBA correlated to aircraft during the study period for comparison.

Table 4.2 Measured Vs Modeled Time Above Sound Levels

Site	TA^{65} Measured (min)	TA^{65} Modeled (min)	Difference (min)
1	6.6	10.0	3.4
2	13.7	19.2	5.4
3	9.4	16.9	7.5
4	8.7	10.9	2.3
5	8.3	24.7	16.4
6	17.8	25.1	7.3

Figure 4.1: Number of Events Above 65 dB per Day

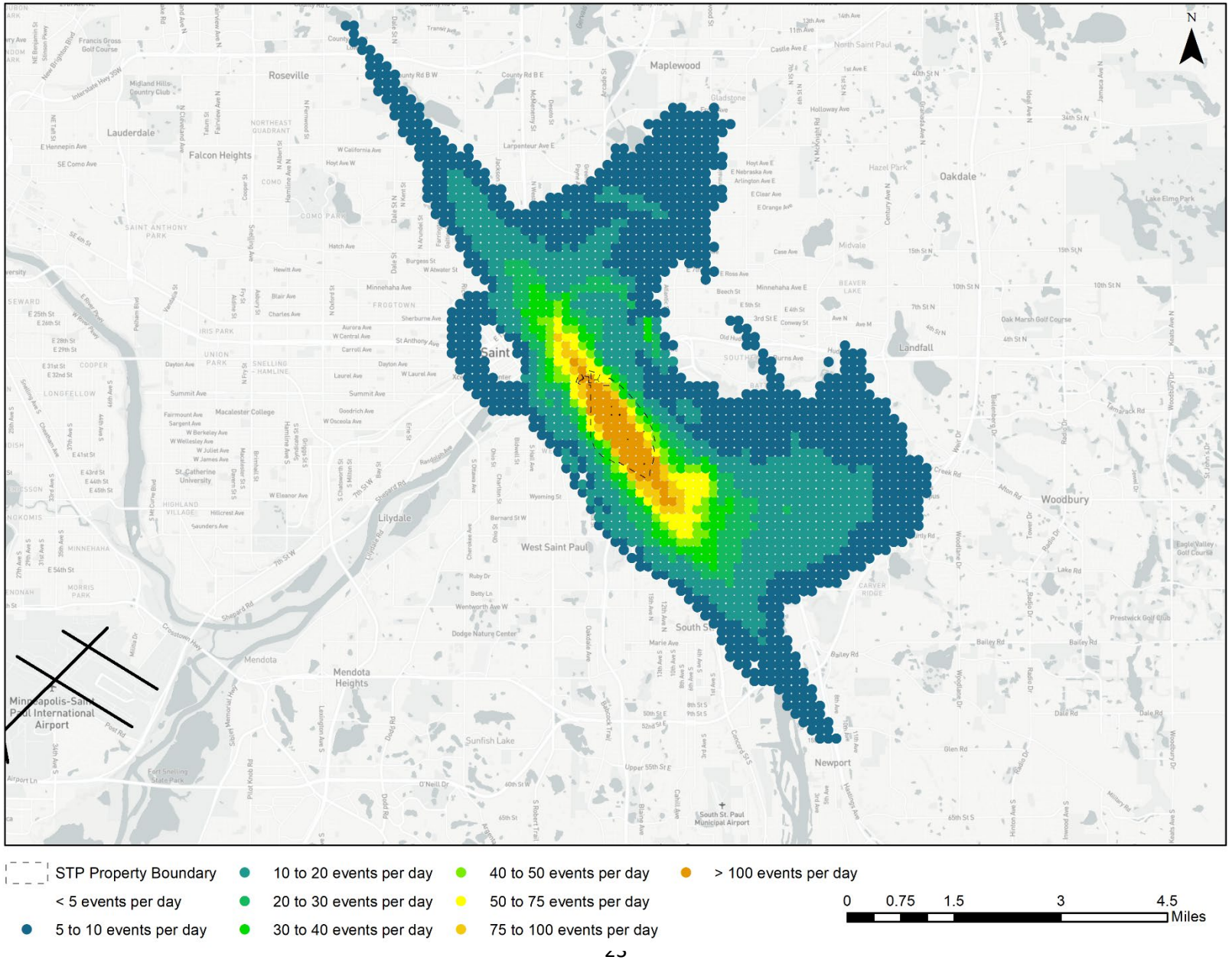
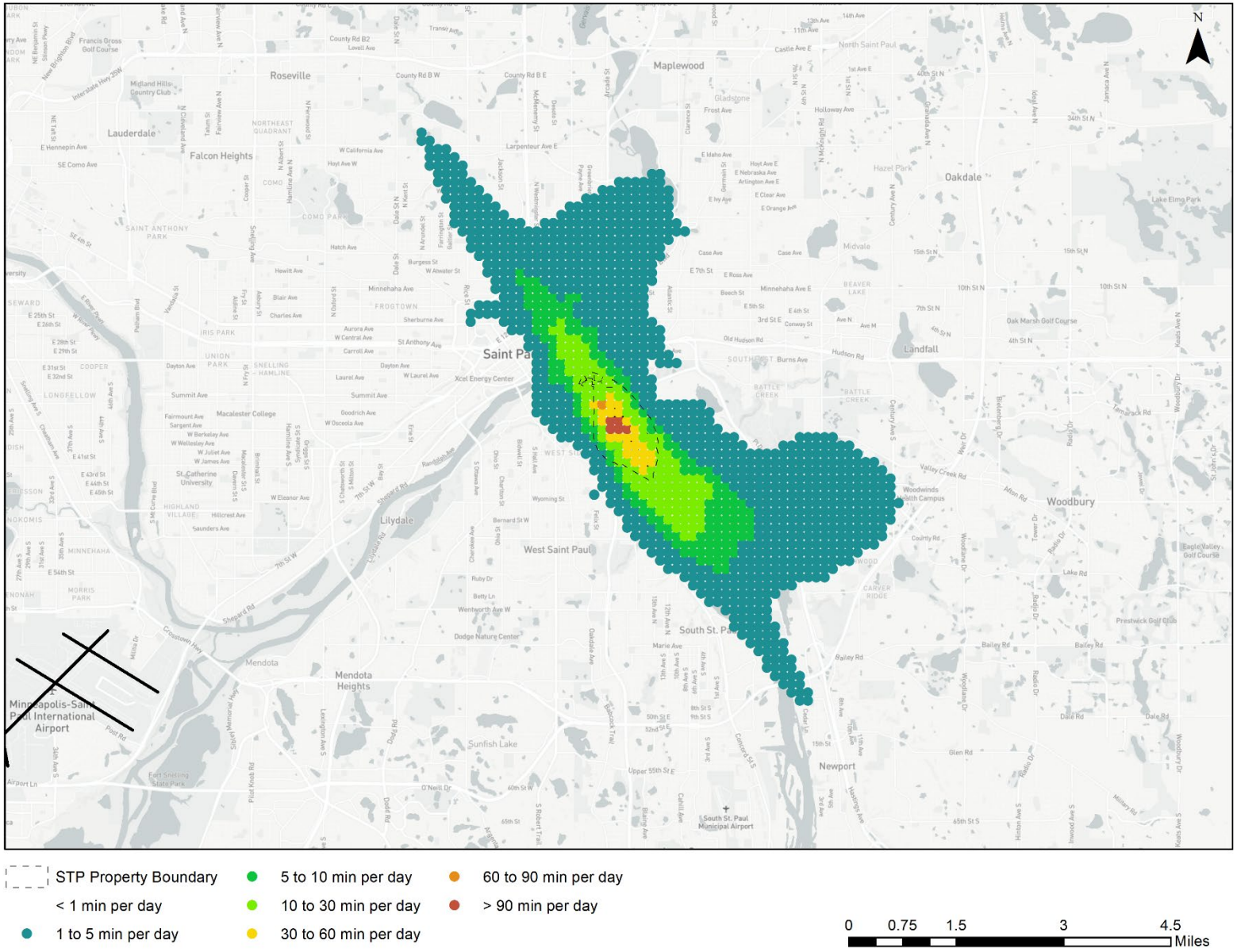


Figure 4.2: Time Above 65 dB (minutes per day)



5.0 Noise Complaints

During the study period, three complaints were received from one Saint Paul household, and two complaints were received from two households in other cities. One complaint was received during nighttime hours, between 10:00 P.M. and 7:00 A.M. Table 4.2 illustrates the complaints with correlated operations by aircraft type. Piston aircraft operated the most flights during the study period and received the greatest number of complaints.

Table 5.1 Complaints and Operations

Aircraft Type	Operations	Complaints
Helicopter	72	-
Jet	239	-
Piston	1,026	-
Turbo-Prop	127	5
Unknown	78	-
Total	**1,544**	**5**

Figure 5.1 shows a complaint heat map representing the number of complaints within a grid square. Figure 5.2 shows complaints and the number of events above 65 dB.

Figure 5.1: STP Study Period Complaint Heat Map

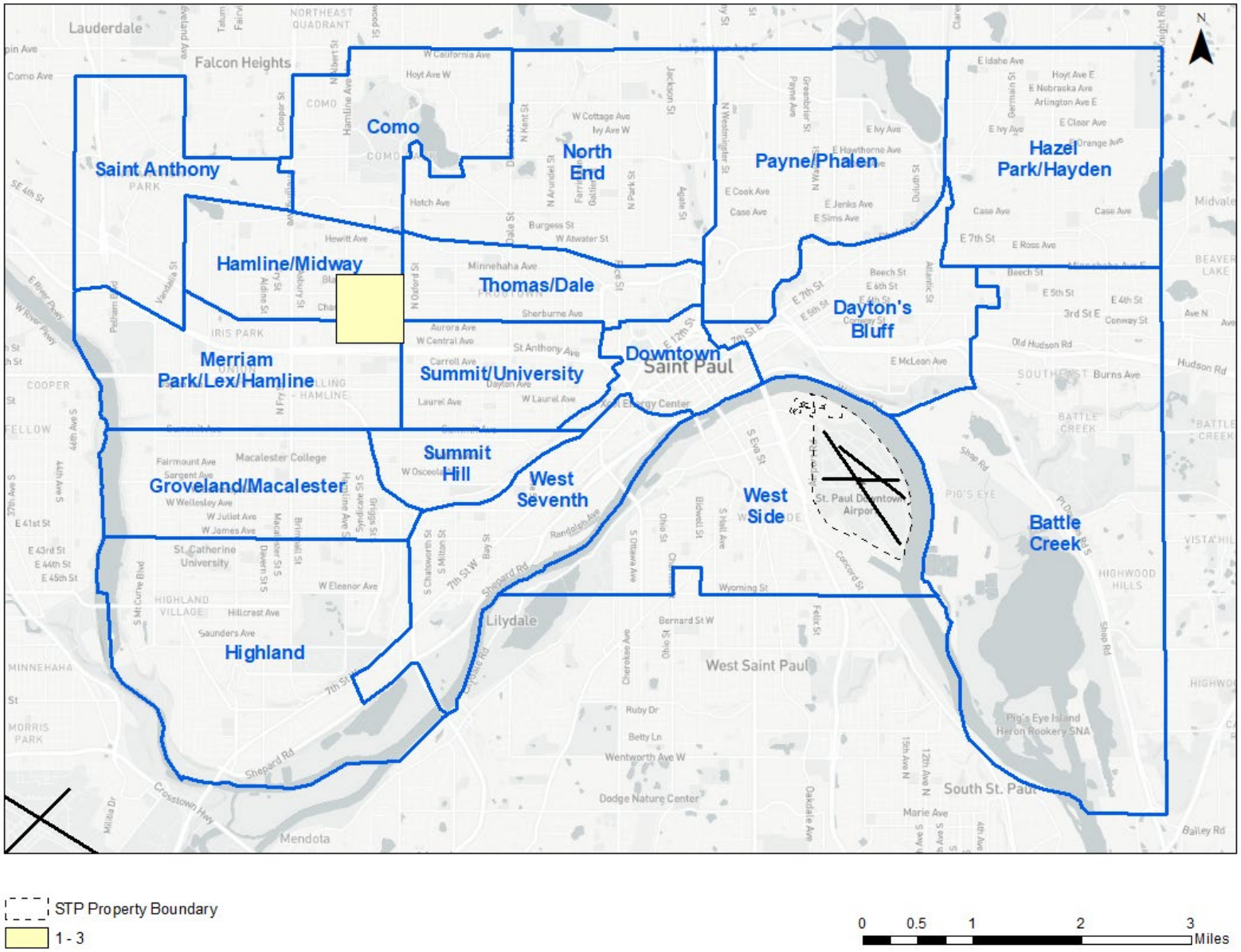
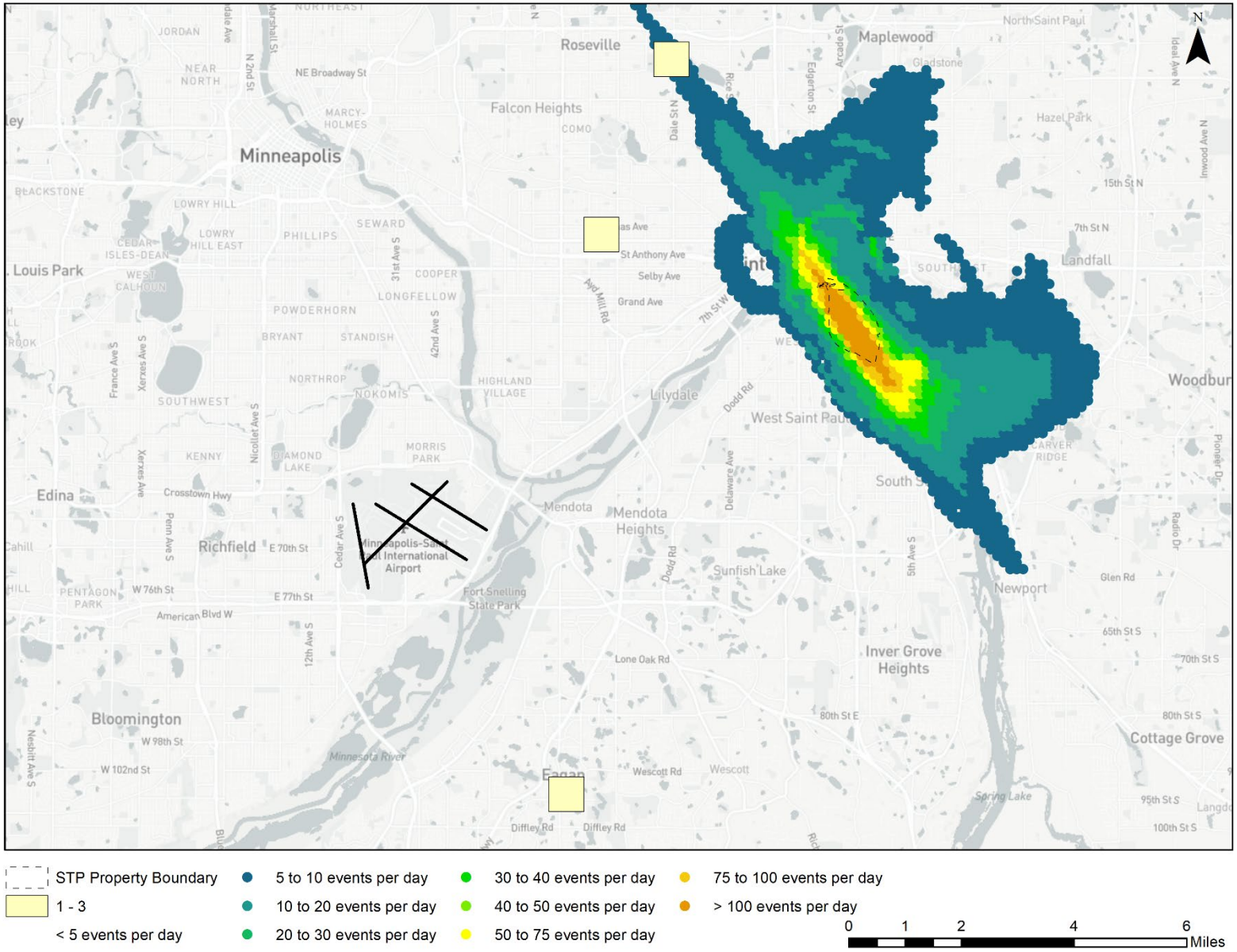


Figure 5.2: STP Study Period Complaint Heat Map with Number of Events Above 65 dB



Appendix

A.1 MAC Mobile Sound Monitoring Request Guidelines

Mobile equipment sites are located to measure sounds near known aircraft flight paths:

- Located where flight operations are at altitudes, concentrations, and configurations creating aircraft sound levels above community sound levels.
- Away from known community sound sources (such as large arterial roads, train tracks, factories, transit centers, natural and other gathering spots) that may interfere with gathering aircraft sound data.
- Availability of power source(s).
- On MAC or public owned property (preferred).

A.2 Field-Measured Sound Data: Aircraft and Community DNL

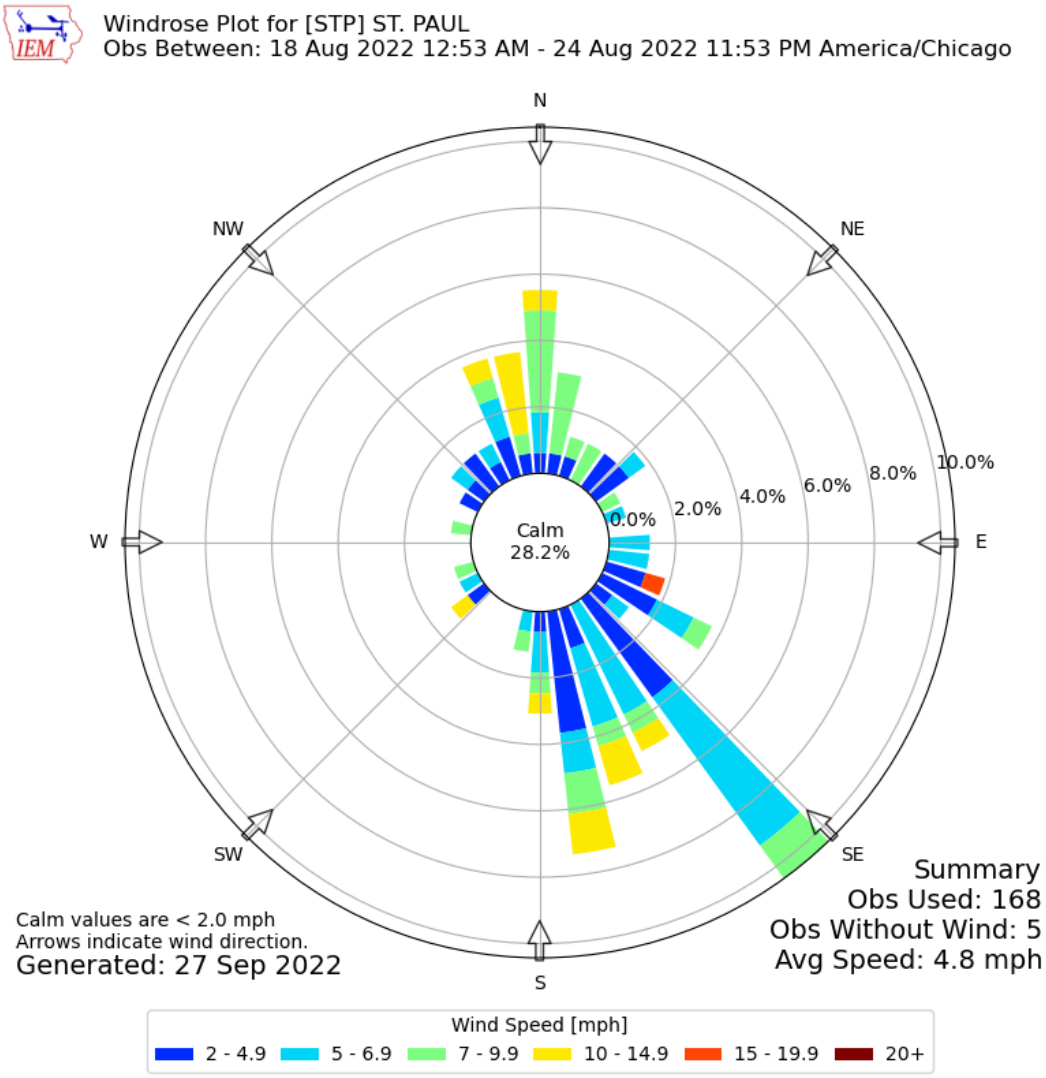
Site	Date	ADNL	CDNL	Combined DNL
1	18-Aug	41.6	59.5	59.6
1	19-Aug	33.6	59.6	59.6
1	20-Aug	37.3	61.3	61.3
1	21-Aug	39.4	61.1	61.1
1	22-Aug	35.6	60.5	60.5
1	23-Aug	28.1	61.0	61.0
1	24-Aug	36.5	61.6	61.6
2	18-Aug	43.5	62.3	62.4
2	19-Aug	35.6	67.6	67.6
2	20-Aug	46.4	63.4	63.5
2	21-Aug	47.6	61.7	61.9
2	22-Aug	46.7	61.8	61.9
2	23-Aug	44.4	61.8	61.9
2	24-Aug	41.8	61.5	61.5
3	18-Aug	49.2	59.6	60.0
3	19-Aug	38.7	58.6	58.6
3	20-Aug	41.4	58.5	58.6
3	21-Aug	41.5	59.3	59.4
3	22-Aug	45.1	61.3	61.4
3	23-Aug	34.1	61.4	61.4
3	24-Aug	35.9	60.5	60.5
4	18-Aug	34.8	60.1	60.1
4	19-Aug	-	59.4	59.4
4	20-Aug	45.6	58.7	58.9
4	21-Aug	43.8	58.7	58.8
4	22-Aug	40.3	58.9	59.0
4	23-Aug	35.6	58.5	58.5
4	24-Aug	35.4	78.7	78.7
5	18-Aug	48.0	59.1	59.4
5	19-Aug	49.0	58.6	59.1
5	20-Aug	45.7	58.1	58.3
5	21-Aug	40.7	57.8	57.9
5	22-Aug	40.4	58.3	58.4
5	23-Aug	37.5	61.1	61.1
5	24-Aug	42.5	62.3	62.3
6	18-Aug	51.3	62.7	63.0
6	19-Aug	46.0	61.1	61.2
6	20-Aug	40.5	61.7	61.7
6	21-Aug	47.9	58.6	59.0
6	22-Aug	46.8	59.4	59.6
6	23-Aug	48.9	61.5	61.7
6	24-Aug	44.5	59.4	59.5

A.4 Modeled Aircraft Distribution

Aircraft Type	Arrival	Departure	Touch and Go	Total Operations
Jet	**147.5**	**142.6**	**4.7**	**294.8**
British Aerospace (BAE) 146-RJ85	1.2	1.2	0.0	2.4
Bombardier Challenger 300	6.1	7.3	0.0	13.4
Bombardier Challenger 350	4.9	4.9	0.0	9.7
Bombardier Challenger 601	2.4	2.4	2.3	7.2
Bombardier Learjet 40	1.2	1.2	0.0	2.4
Bombardier Learjet 45	2.4	2.4	0.0	4.9
Bombardier Learjet 60	1.2	1.2	0.0	2.4
Cessna 500 CitationJet I	2.4	2.4	0.0	4.9
Cessna 525B CitationJet (CJ3)	3.6	1.2	0.0	4.9
Cessna 525C CitationJet	7.3	7.3	0.0	14.6
Cessna 550 Citation II	3.6	3.6	0.0	7.3
Cessna 560 Citation Encore	3.1	3.1	0.0	6.3
Cessna 560 Citation Ultra	1.7	1.7	0.0	3.4
Cessna 560 Citation XLS	17.0	14.6	0.0	31.6
Cessna 650 Citation III	2.4	2.4	0.0	4.9
Cessna 680 Citation Sovereign	6.1	8.5	0.0	14.6
Cessna 680 Citation Longitude	0.0	1.2	0.0	1.2
Cessna 750 Citation X	4.9	3.6	0.0	8.5
Cessna Vision SF50 (FAS)	1.2	1.2	0.0	2.4
Dassault Falcon 2000	17.0	17.0	0.0	34.0
Dassault Falcon 50	6.1	4.9	0.0	10.9
Dassault Falcon 900	1.2	3.6	0.0	4.9
Embraer Legacy 550 (EMB-550)	2.4	2.4	2.3	7.2
Embraer Phenom 100 (EMB-500)	6.1	4.9	0.0	10.9
Embraer Praetor 500	1.2	1.2	0.0	2.4
Falcon 7X	1.2	0.0	0.0	1.2
Gulfstream G280	2.4	2.4	0.0	4.9
Gulfstream G400	2.4	2.4	0.0	4.9
Gulfstream G500	14.6	14.6	0.0	29.1
Gulfstream II	6.1	4.9	0.0	10.9
Honda HA-420 Hondajet	1.8	1.8	0.0	3.6
Raytheon Beechjet 400	9.7	9.7	0.0	19.4
Raytheon Hawker 800	2.4	1.2	0.0	3.6
Piston	**186.9**	**193.0**	**751.6**	**1,131.6**
Single Engine	**174.8**	**179.7**	**735.3**	**1,089.7**
Beechcraft Bonanza 33 (FAS)	1.2	1.2	3.6	6.1
Beech 77 Skipper (FAS)	0.0	1.2	0.0	1.2
Cessna 140 (FAS)	1.2	1.2	0.0	2.4
Cessna 150 Series	25.5	26.7	196.4	248.6
Cessna 152 (FAS)	3.6	3.6	18.7	26.0
Cessna 172 Skyhawk	65.6	64.3	306.2	436.1
Cessna 180 (FAS)	1.2	1.2	0.0	2.4
Cessna 182	8.5	8.5	0.0	17.0
Cessna 206	2.4	3.6	2.3	8.4
Cirrus SR20	3.6	3.6	0.0	7.3
Cirrus SR22 Turbo (FAS)	6.1	4.9	14.0	25.0
Lancair Evolution (FAS)	0.0	1.2	0.0	1.2
Mooney M20-K	2.4	3.6	0.0	6.1
Piper PA-28 Cherokee Series	47.3	49.8	191.7	288.8

Aircraft Type	Arrival	Departure	Touch and Go	Total Operations
Piper PA-32 Cherokee Six	2.4	2.4	2.3	7.2
Piper PA44 (FAS)	1.2	1.2	0.0	2.4
Raytheon Beech Bonanza 36	2.4	1.2	0.0	3.6
Multi Engine	**12.1**	**13.4**	**16.4**	**41.8**
Beech 95 (FAS)	7.3	6.1	16.4	29.7
Cessna 310	2.4	2.4	0.0	4.9
Cessna 402	1.2	1.2	0.0	2.4
Cessna 414	1.2	2.4	0.0	3.6
Cessna 421	0.0	1.2	0.0	1.2
Turboprop	**78.9**	**80.1**	**2.3**	**161.4**
Single Engine	**29.1**	**31.6**	**2.3**	**63.0**
Cessna 208 Caravan	2.4	3.6	0.0	6.1
EPIC LT/Dynasty	0.0	1.2	0.0	1.2
Pilatus PC-12	17.0	15.8	0.0	32.8
Quest Kodiak 100	4.9	4.9	0.0	9.7
Vans RV12 (FAS)	2.4	3.6	2.3	8.4
Socata TBM-9 (FAS)	2.4	2.4	0.0	4.9
Multi Engine	**49.8**	**48.6**	**0.0**	**98.3**
Aero Commander 680 Turbo Commander	1.2	1.2	0.0	2.4
Raytheon Beech 99	1.2	0.0	0.0	1.2
Raytheon King Air 90	4.9	4.9	0.0	9.7
Raytheon Super King Air 200	35.2	34.0	0.0	69.2
Raytheon Super King Air 300	7.3	8.5	0.0	15.8
Helicopter	**34.0**	**34.0**	**0.0**	**68.0**
Single Engine	**0.0**	**0.0**	**0.0**	**0.0**
Multi Engine	**34.0**	**34.0**	**0.0**	**68.0**
Bell 407 / Rolls-Royce 250-C47B	2.4	3.6	0.0	6.1
Robinson R44 Raven / Lycoming O-540-F1B5	31.6	30.4	0.0	61.9
Bell 407 / Rolls-Royce 250-C47B	2.4	3.6	0.0	6.1
Grand Total	**447.3**	**449.8**	**758.7**	**1,655.7**

A.5 STP Weather Details

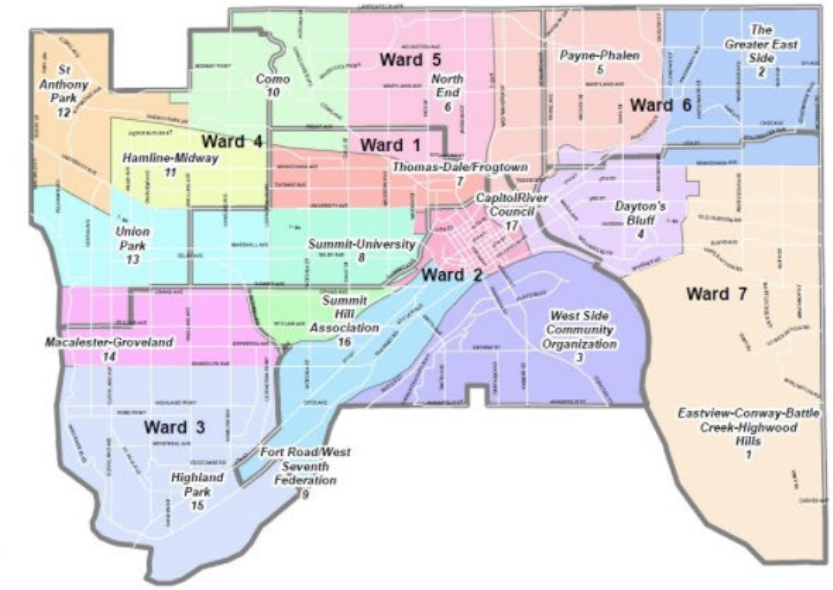


Source: [Mesonet Iowa State]

Table A.1: Model Weather Inputs	
Average Temp	71.5
Average Wind Speed	13.0
Average Dew Point	60.5
Average Sea Level Pressure (SLP)	29.1
Average Relative Humidity	69.9
Average SLP (millibar)	986.8

A.6 Saint Paul District Council Map and Details

District Council Directory



District	Neighborhood	District Council
1	Eastview - Conway - Battle Creek - Highwood Hills	District 1 Community Council
2	Greater East Side	District 2 Community Council
3	West Side	West Side Community Organization
4	Dayton's Bluff	Dayton's Bluff Community Council
5	Payne-Phalen	Payne Phalen Community Council
6	North End	North End Neighborhood Organization
7	Thomas-Dale/Frogtown	Frogtown Neighborhood Association
8	Summit-University	Summit-University Community Council
9	West 7th/Fort Road	Fort Road Federation
10	Como	District 10 Como Community Council
11	Hamline-Midway	Hamline Midway Coalition
12	St. Anthony Park	St. Anthony Park Community Council
13	Union Park	Union Park District Council
14	Macalaster-Groveland	Macalester Groveland Community Council
15	Highland	Highland District Council
16	Summit Hill	Summit Hill Association
17	Downtown	Capitol River Council

Source: www.stpaul.gov/residents/live-saint-paul/neighborhoods/district-councils/district-council-directory

A.7 Supplemental Conditions of Agreement

METROPOLITAN AIRPORTS COMMISSION

Minneapolis-Saint Paul International Airport
6040 - 28th Avenue South • Minneapolis, MN 55450-2799
Phone (612) 726-8100

TO WHOM IT MAY CONCERN:

On June 19, 2006 the following action took place at the Metropolitan Airports Commission full Commisson meeting regarding the St. Paul Downtown Airport – Flood Protection Update:

COMMISSIONER MARS MOVED AND COMMISSIONER LANNERS SECONDED TO INCREASE THE AMOUNT FOR THE PROJECT IN THE CAPITAL IMPROVEMENT PROGRAM FROM $28.5 MILLION TO $29.3 MILLION AND AUTHORIZE STAFF TO INCLUDE THE CONDITIONS THAT WERE PRESENTED TO THE COMMITTEE IN THE ZONING APPLICATION WHEN RESUBMITTED TO THE CITY. FURTHER THAT STAFF WORK WITH PUBLIC AND PRIVATE PARTIES THAT WILL DIRECTLY BENEFIT FROM THE FLOOD PROTECTION PROJECT TO RAISE REVENUES TO OFFSET THE COST INCREASE.

The Motion passed unanimously by the following roll call vote:

Commissioners: **Berman, Boivin, Harris, Landy, Lanners, Mars, McGee, Rehkamp, Sigel, Warner, Williams and Chair McKasy**

Absent: **Commissioners Foley and Stenerson**

Sallye Douma, Commission Secretary

Runway Length MAC will not take any action to increase the length of the runways at the Airport in excess of the current length, unless required to do so by State law, provided that MAC will not initiate, promote or otherwise support enactment of such law.

Pavement Strength MAC will not take any action to increase the Runway Pavement Weight-Bearing Capacity at the Airport beyond the maximum presently available, unless required to do so by State law, provided that MAC will not initiate, promote or otherwise support enactment of such law.

Cargo Operations MAC represents that, based on operational and space limitations, major air cargo transfer/sortation operations (such as Federal Express, UPS and other similar companies) are not able to use the Airport, nor will MAC take action to accommodate such activity.

Airport Noise Abatement Plan MAC will, in consultation and collaboration with the City and other interested parties (agreed to by MAC and the City), immediately initiate an update of the St. Paul Downtown Airport Noise Abatement Plan to include the following elements:

- Use of the runways at the Airport.
- Appropriate flight tracks for aircraft arriving at, or departing from, the Airport.
- Voluntary restraint on night-time aircraft operations and recommended procedures for any such operations that must occur.
- Voluntary restraint on night-time aircraft engine runups.
- Implementation of a pilot/FBO information and education program designed to inform Airport Users and Fixed Base operators of the elements contained in the Noise Abatement Plan.
- Completion of an annual study of aircraft noise in the areas surrounding the Airport.
- Incorporation of limitations regarding runway length, runway strength and cargo operations.
- Public Input.

As necessary, MAC will seek Federal Aviation Administration approval of the updated noise abatement plan. MAC shall use its best efforts to secure federal approval of the plan or any portion of the proposed plan.

Endangered/Threatened Species MAC will coordinate with the City of St. Paul and other appropriate agencies to complete an updated survey of threatened/endangered species within the project area.

Vegetation/Revegetation Plan MAC will coordinate with the City of St. Paul and other interested parties to review and make recommendations regarding a vegetation/revegetation plan for the project area. MAC will implement these recommendations if they are determined to be compatible with Airport operations.

Treatment of Contaminated Soils MAC will complete additional soil sampling and testing in the area proposed for compensatory excavation, including testing for PAH's and inorganics. MAC will also monitor excavated material from the compensatory excavation per a Testing and Disposal Plan. Any contaminated soils will be properly disposed of in a licensed facility approved for such disposal.

Stormwater Discharge MAC will complete a sampling/testing protocol for subdrain discharge, as may be required by the Minnesota Pollution Control Agency.

A.8 Glossary

Aircraft Operation

Aircraft arriving or departing from STP, or an aircraft that performed both an arrival and departure (touch and go).

A-Weighting

A-Weighting is a standard filter used by acoustic measurement devices and can be applied to acoustic measurements. It is frequency filter that attempts to emulate the way human hear.

Day-Night Level (DNL)

The FAA established DNL as the primary metric for aircraft noise analysis and expressing aircraft noise exposure in the United States. "DNL" is the acronym for Day-Night Average Sound Level, which represents the total accumulation of all sound energy, with a 10-decibel penalty applied for each sound event between 10:00 P.M. and 7:00 A.M. DNL has been widely accepted as the best available method to describe aircraft noise exposure and is the industry standard for use in aircraft noise exposure analyses and noise compatibility planning. It also has been identified by the U.S. Environmental Protection Agency as the principal metric for airport noise analyses.

Decibel (dB/dBA)

Sound levels are measured in Decibels, a logarithmic scale of energy referenced to human hearing. Sound levels are reported in dB; dBA is the Decibel value after the A-Weighting filter is applied.

LA_{eq} (Equivalent Sound Level) Equivalent sound level

The representation of a time-varying sound as an equivalent steady state A-weighted sound level for the period or interval of interest.

LA_{max} (Maximum A-weighted Sound Level)

This is maximum A-Weighted Sound Level observed for the period, event, or interval of interest.

LA_{90} (Sound Level Exceeded 90 Percent of the Time)

The LA90 is a common and typical method to estimate ambient sound levels or background sound levels seen most of the time. It is a statistical based metric which provides us with which A-Weighted sound level that is exceeded 90 percent of the time.

Number Above

The "Number Above", also referred to as N-level sound metric or Count Above, is the total number of aircraft sound events that exceeded a specified sound level threshold (LA_{max}). This report contains a count

of departure events and arrival events recorded with field-measurement equipment when the maximum sound level of those events exceeds 65, 80, 90, and 100 dB levels.

SEL (Sound Exposure Level)

Sound Exposure Level is the total sound energy expressed in one second. Numerically, the energy is equivalent but allows for the comparison of sound events with varying durations.

Time Above Metric

The "Time Above" noise metric measures the total time or percentage of time that the A-weighted aircraft noise level exceeds an indicated level. Time Above data are summarized for arrival and departure events based on one-second intervals.

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