

2016 AERONAUTICAL NOISE MANAGEMENT REPORT

-VANCOUVER AIRPORT AUTHORITY-

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INTRODUCTION

Vancouver Airport Authority (“Airport Authority”) is a not-for-profit organization, governed by a community-based Board of Directors, and oversees the daily operations of the Vancouver International Airport (“YVR”) to ensure the airport runs safely and efficiently. As a community based organization, the Airport Authority is committed to a positive long-term relationship with our surrounding communities and is dedicated to operating YVR in a manner that minimizes negative impacts on the environment, while providing 24-hour airport services.

The Airport Authority took over management of YVR from Transport Canada in 1992. Managing noise from aircraft operations has been a priority for us since assuming responsibility of YVR.

As with all work undertaken by the Airport Authority, we approach noise management using a sustainability framework, which integrates the economic, environmental, social and governance aspects of our business. This framework is essential to our success and provides a responsible approach for our business objectives and our commitment to the local community.

The objective of this report is to share information with the community about activities of the YVR Aeronautical Noise Management Program, and to facilitate informed dialogue between stakeholders involved in managing aircraft noise. Data and information compiled for this report also helps to support discussions with members of the YVR Aeronautical Noise Management Committee (“ANMC”), a consultative forum for independently appointed community and industry representatives to share information and provide advice and input on the development of initiatives to the Airport Authority through a collaborative process.

2016 HIGHLIGHTS

The Airport Authority has a comprehensive program to manage noise from aircraft and airport operations. The YVR Aeronautical Noise Management Program has many elements, and the 5-year YVR Noise Management Plan is an integral part of advancing the goals of the program. The Noise Management Plan is a requirement under the Airport Authority's ground lease with Transport Canada, and the current Plan (2014-2018) can be found at www.yvr.ca.

The 2014-2018 YVR Noise Management Plan contains ten focus areas along with supporting initiatives. A summary of work undertaken in 2016 is provided below.

YVR 2037 MASTER PLAN

In 2016, the YVR Master Plan team carried out Phase 2 of consultations on the YVR 2037 Master Plan. This phase focused on the following six key areas: airport terminal; airside and airspace; ground access; community amenities; environment; and land use. Input and feedback on these six key areas were received from stakeholder groups and communities through meetings, workshops, open houses, roadshows, and online materials. The overall comments and feedback received during Phase 2 were positive and supportive of the YVR 2037 Master Plan work. A detailed report summarizing the results of consultations can be found on www.yvr2037.ca.

In support of the YVR 2037 Master Plan process, the following noise related work was undertaken:

Noise Exposure Forecast (NEF) Contour Assessment

The NEF is the official metric prescribed by Transport Canada for airport noise assessment in Canada. These contours are created using special software made available by Transport Canada. The NEF provides a measure of the actual and forecast aircraft noise in the vicinity of airports, and the sole purpose of the NEF is to help aviation planners, and those responsible for developments adjacent to airports, implement compatible land use practices. The current NEF contour for YVR that is used for long term land use planning was created in 1994 using 20-year forecast period extending to 2015.

A review of the 2015 NEF contour was initiated to assess its continued use as a long range planning tool and its ability to protect for the expected traffic growth over the next 20-years and the addition of a new future runway. This work will be completed in early 2017.

Noise Communication Materials

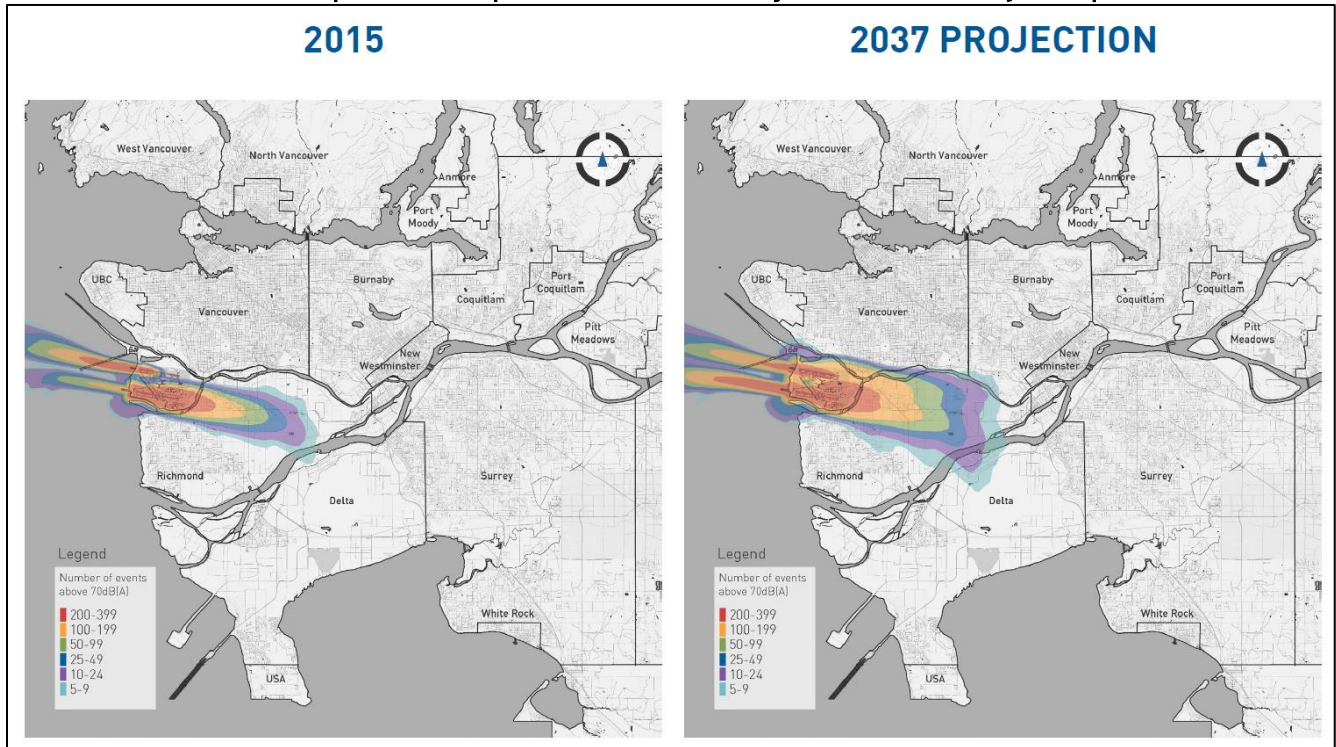
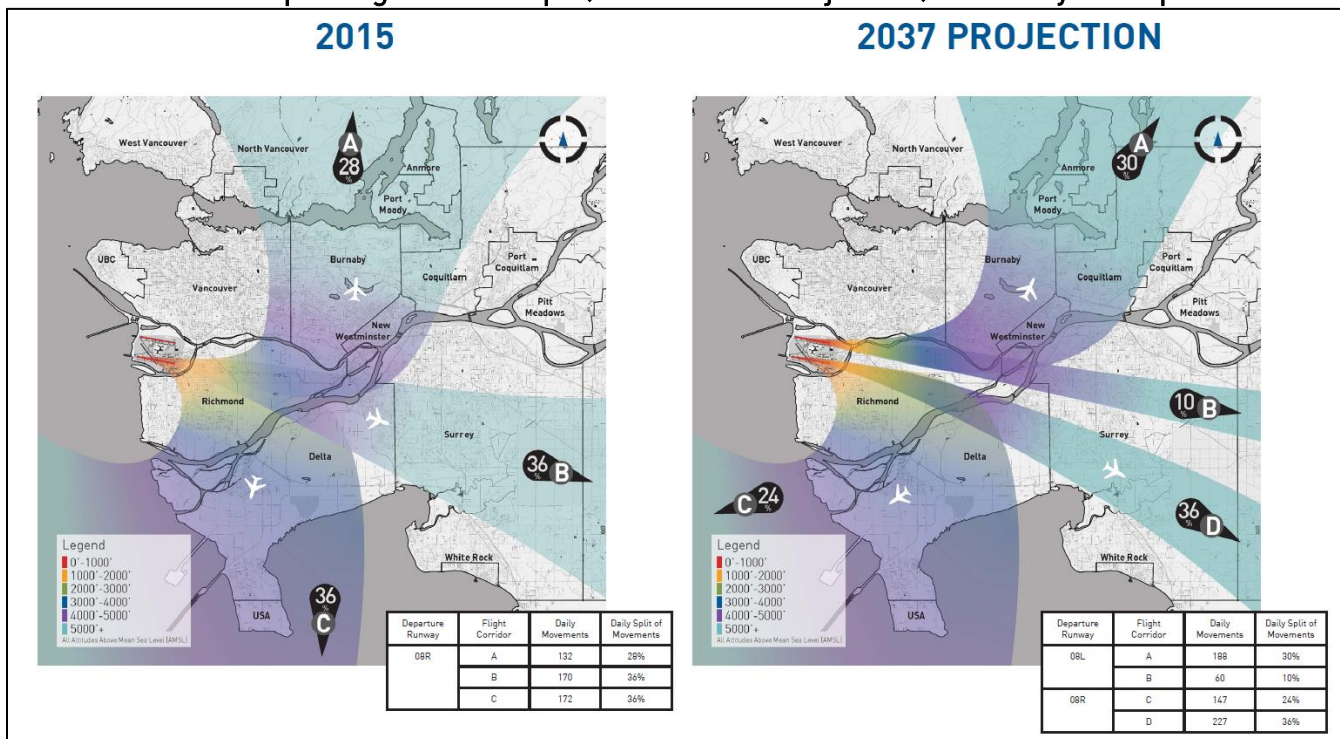
While the NEF is official metric for airport noise assessment which assists with land use planning, it may not be the most effective tool to communicate noise exposure or flight activities to communities. To help communicate potential noise impacts associated with future growth at YVR, the Airport Authority assessed the use of supplementary noise metrics and created the following materials:

- N70 maps to illustrate the number of aircraft events above 70 dBA over a given 24-hour period; and
- Flight path maps to illustrate generalized flight routes and aircraft distribution over the Metro Vancouver area over a give 24-hour period.

To compare possible changes between the current and future operations, actual traffic movements from a busy day in 2015 was compared against forecasted traffic movements for a peak planning day in 2037. Multiple operating scenarios were created to account for the effect of active runway direction on air traffic patterns over the Lower Mainland.

A number of assumptions had to be made to create the future scenarios given the long time period involved. Assumptions were based on best information currently available for flight paths and procedures, and simplification of a complex airspace over the Lower Mainland. As a result, the material is meant to provide a highly generalized depiction of how future growth may alter aircraft distribution and noise patterns over the Lower Mainland compared to the current operations. In the event of any future changes to flight paths and procedures, the Airport Authority is committed to working collaboratively with NAV CANADA and the ANMC to ensure the community is engaged and communicated with.

Figure 1 and 2 illustrate sample N70 and flight track maps created for the YVR 2037 Master Plan process. The complete set of these maps and further information can be found on www.yvr2037.ca/noise.

FIGURE 1: Sample N70 Maps (2015 & 2037 Projection) - Runway 08 Operations

FIGURE 2: Sample Flight Path Maps (2015 & 2037 Projection) - Runway 08 Departures


RESEARCH INTO THE USE OF INCREASED GLIDESLOPE FOR NOISE MITIGATION

In 2016, the Airport Authority completed research into the use of increased glideslope¹ as a noise abatement measure by reviewing trials at Frankfurt Airport (“Frankfurt”) and London Heathrow Airport (“Heathrow”).

Since 1970s, the international standard for glideslope approach angle set by Civil Aviation Organization (ICAO) has been 3.0° with the exception of airports that require a steeper approach for obstacle clearance. ICAO currently precludes the use of steeper approaches for reasons other than to meet the obstacle clearance requirements.

However, the use of a steeper approach angle may help reduce noise by placing arriving aircraft at a higher altitude at a given distance from the runway. As such, Frankfurt and Heathrow recently trialed the use of a 3.2° approach angle for noise abatement.

The approach angle of 3.2° was selected as simulations studies had determined that it could be flown in CAT I conditions without any modifications to aircraft or flight procedures. Theoretically, the use of a 3.2° approach angle would place aircraft approximately 170 feet higher compared to the use of a traditional 3.0° approach angle at a distance of 8 nautical miles (nm) away from the airport.

The majority of aircraft operating today are not certified to fly steeper approaches in CAT III conditions. As a result, the use of the 3.2° approach angle could only be offered in CAT I conditions, and the airports had to have both the 3.0° and 3.2° approach angles available during the trials to prevent operational disruptions in low visibility conditions.

To accommodate both approach angles, Frankfurt used the dual ILS capability on the runway associated with the trials and increased the approach angle for the CAT I ILS to 3.2° while keeping the approach angle for the CAT III ILS at 3.0°. Because Heathrow does not have dual ILS capability, they amended their Area Navigation (RNAV)² to accommodate an approach angle of 3.2° and maintained the ILS approach angle at 3.0°. As the ILS approach is the most used instrument approach system at airports, the usage of 3.2° approach was much lower at Heathrow than Frankfurt.

¹ Glideslope is one of the components of the Instrument Landing System (ILS) that provides vertical guidance to aircraft landing. ILS is a ground-based instrument approach system which is currently the most widely used instrument approach system at airports.

² RNAV is a satellite based navigation method that allows aircraft to fly any desired flight paths instead of following the conventional routes designed based on ground navigation system.

Overall, both Frankfurt and Heathrow reported positive outcomes. Their trials demonstrated that the 3.2° approach angle could be adopted without negative impacts to aircraft operations. Measured noise reductions of up to -1.5 dBA were also observed during the trials. While a 1.5 dBA reduction in the noise level is not perceptible to the average human ear, it may provide opportunities to reduce the overall noise exposure under the approach path.

Because the 3.2° approach angle could only be achieved during CAT I conditions, airports must maintain the standard 3.0° approach angle to prevent any disruptions during low visibility in order to trial and implement a steeper approach; therefore, some form of dual ILS capability is required. The installation and maintenance of a dual ILS can be costly, and some airports may not have sufficient area on their airfield for the required additional ground equipment.

Based on this research study, the Airport Authority has concluded that using an increased glideslope for noise abatement is not recommended for YVR at this time due to the high cost of a dual ILS and the small amount of noise reduction achieved. However, the Airport Authority will continue to monitor changes to ICAO standards and use of increased approach slopes and other noise mitigation measures at other airports.

NOISE MONITORING AT THE MUSEUM OF VANCOUVER

Temporary noise monitoring was undertaken at the Museum of Vancouver between the dates of 5 March and 24 April 2016. This site was selected in discussions with the YVR Aeronautical Noise Management Committee to understand and collect baseline information on the current aircraft noise exposure in the area.

During the 51-day monitoring period, a total of 2,674 noise events were registered at the site. Of these events, 4% (n=108) were related to YVR aircraft, 21% (n=568) were related to non-YVR aircraft, and the remaining 75% (n=1,998) were associated with non-aircraft noise sources.

The analysis of noise data collect at the Museum of Vancouver concluded that community noise sources have greater contribution to the overall noise environment than aircraft noise in the area. A detailed summary report is available at www.yvr.ca.

SUMMER 2016

Summer months are typically the busiest season at YVR with the high volume of aircraft traffic and a number of airfield projects. In 2016, the Airport Authority completed the second year of a three-year project to construct Runway End Safety Areas on the south and crosswind runways. This work required the night-time closure of south runway for an extended period. The north runway was also used to accommodate departures during peak periods to reduce congestion and delays. A summary of the major activities is provided below.

Runway End Safety Area (RESA) Construction Project

In 2016, the Airport Authority completed the second year of a three-year project to construct RESAs on the south airfield. RESAs are specialized areas at the end of a runway that protect and reduce severity of damage to an aircraft in the unlikely event of an overrun or undershoot. The Airport Authority is proactively building RESAs to meet international recommendations and to exceed the anticipated Canadian standard.

Nightly construction of RESAs began on 8 May, and the south runway was closed 6 nights a week (Sun-Fri) between 10 PM and 7 AM. During these hours, the north runway was used for all departures and arrivals. While no work occurred on Saturday nights and stat holidays, the north runway had to be used for landings as the Instrument landing System (ILS) on the south runway was out of service due to the construction work.

The 2016 RESA project work was scheduled to be completed on the morning of 2 September. However, due to poor weather conditions experienced in June and July, a two-week extension was required and the work was eventually completed on the morning of 17 September.

North Runway Departures to Reduce Delays

As traffic demand continues to grow during peak hours, the Airport Authority authorized the strategic use of north runway for departures in the summer months between 7 AM and 8 PM to reduce the level of congestion on the airfield.

Between June and August 2016, a total of 599 departures occurred on the north runway for the purposes of delay reduction. Of these departures, 97% (n=583) were domestic flights, 2% (n=12) were international flights, and 1% (n=4) were transborder flights. As the majority of domestic flights were regional flights operating within the province of British Columbia, propeller aircraft were the most common aircraft type assigned to depart on the north runway, making up 74% (n=443) of all the departures.

The use of the north runway for departures to reduce delay will be reassessed for the summer 2017 season based on the amount of airfield projects, forecasted demands, and staffing level at NAV CANADA.

FLY QUIET AWARDS

The 2015 YVR Fly Quiet Awards were presented at the YVR Chief Pilots Meeting in April 2016. The goal of these awards is to raise awareness of noise issues within the aviation community. Eligibility criteria include:

1. The airline must not be in suspected violation of any of the published Noise Abatement Procedures.
2. The airline must have the lowest average annual noise level for their aircraft category (as measured by the Aircraft Noise & Operations Monitoring System).
3. The airline must fly regular services at YVR.

The winners included: WestJet Encore (propeller category); American Airlines (narrow-body jets); and All Nippon Airways (wide-body jets). Award winners for the past three years are presented in Table 1.

TABLE 1: YVR Fly Quiet Award Winners, 2013-2015

YEAR	Propeller	Narrow Body Jets	Wide Body Jets
2015			
2014			
2013			

YVR OPERATIONS IN REVIEW

In 2016, aircraft movements, cargo tonnage and total passengers all experienced growth. In particular, as shown in Table 2 below, the number of passengers increased by almost 10% while the number of aircraft movements increased by 1% compared to 2015.

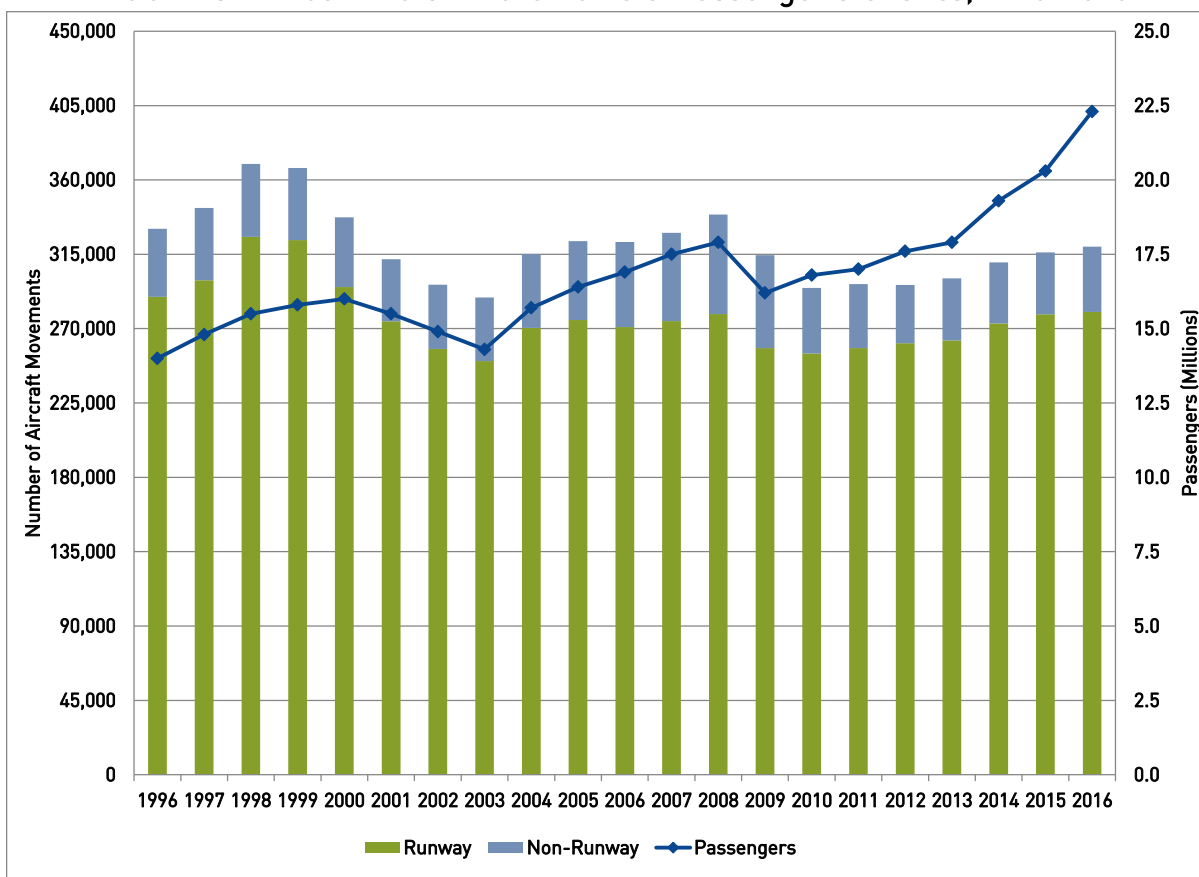
Figure 3 illustrates the historical trend of aircraft movements and passengers at YVR for the time period of 1996-2016. In 2016, the number of aircraft operations was less than what occurred in the peak years in 1998 and 1999 while the number of passengers surpassed its record year in 2015.

The trends in Table 2 and Figure 3 indicate that aircraft are carrying more passengers per aircraft, which is a benefit with respect to noise and emissions.

TABLE 2: Operational Statistics for YVR, 2016

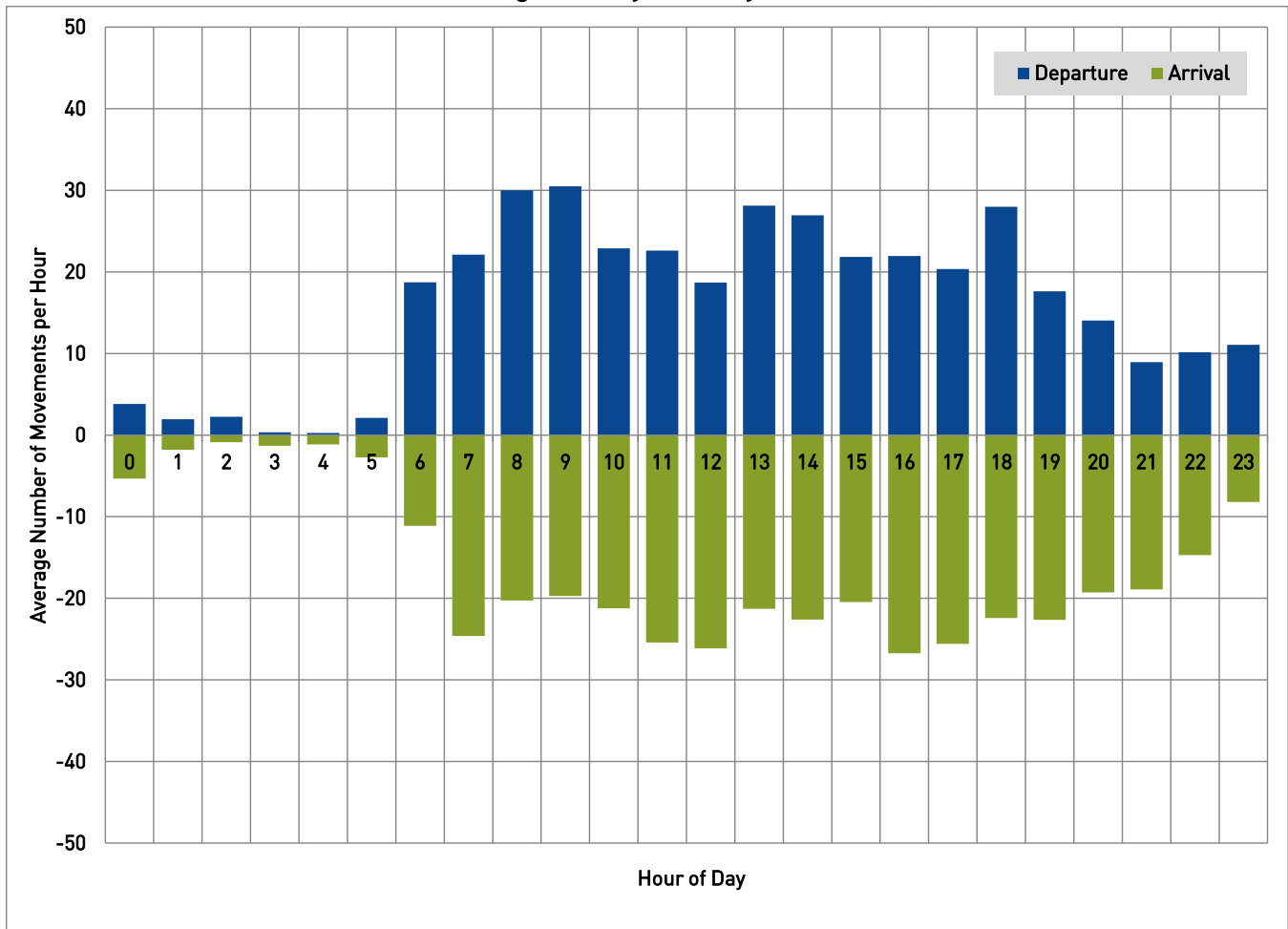
Total Movements	319,593	1.1% increase from 2015
Total Cargo (Tonnes)	281,018	3.4% increase from 2015
Total Passengers	22,288,926	9.7% increase from 2015

FIGURE 3: Annual Aircraft Movements & Passenger Statistics, 1996-2016



In 2016, approximately 97% of aircraft movements occurred during the day-time hours³ and approximately 3% of aircraft movements during the night-time hours⁴. Figure 4 illustrates the average hourly runway movements by arrival and departure. As illustrated, the number of aircraft movements starts to increase at 6:00 AM and continue with peaks experienced throughout the day.

FIGURE 4: Average Hourly Runway Movements, 2016



³ For this report, day-time is defined as the time period between 6:00 AM and midnight.

⁴ For this report, night-time is defined as the time period between midnight and 6:00 AM.

OPERATIONAL SNAPSHOT – NIGHT OPERATIONS

Like most international airports around the world and all international airports in Canada, YVR is open 24-hours a day. While the majority of aircraft activities occur during the day-time hours, some operations occur during the night-time hours. Night-time operations are primarily associated with cargo and courier business; however, there are also a number of scheduled passenger flights.

In 2016, there were approximately 8,740 movements during the night-time hours. This equates to an average of 24 movements per night over period from midnight to 6:00 AM. Of these movements, approximately 55% were arrivals, which are generally quieter than departures. Table 3 summarizes the breakdown of the average night-time movements by aircraft type and operation.

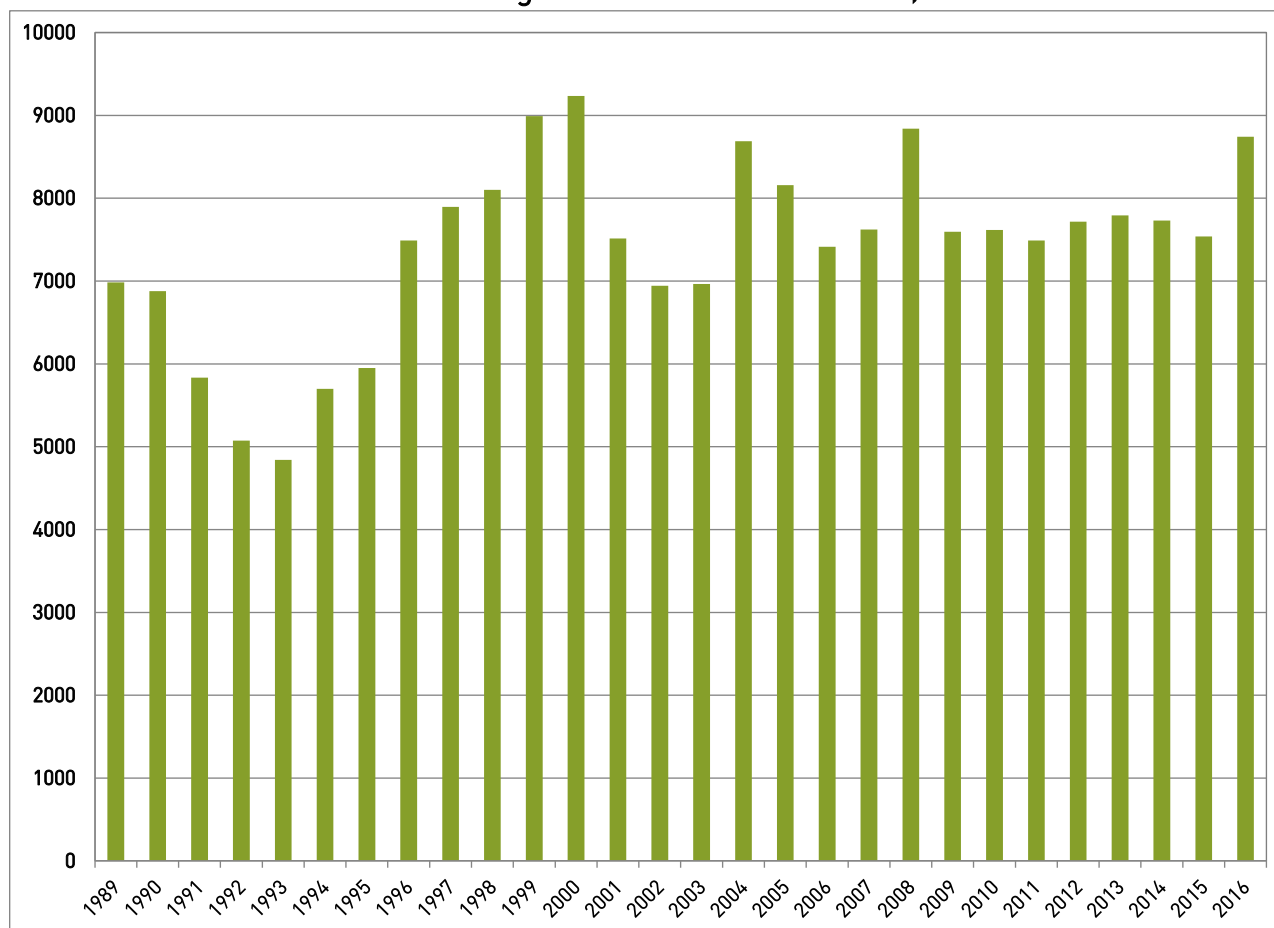
TABLE 3: Average Nightly Movements by Aircraft Type and Operation, 2016

Aircraft Type	Operation	
	Arrival	Departure
Propeller	3	2
Business Jet	1	1
Narrow Body Jet	7	2
Wide Body Jet	3	6

- Propeller aircraft include types such as the Dash-8, Navajo, Beech 1900, Saab 340, etc.
- Business jets include types such as the Citation, Learjet, etc.
- Narrow-body jets include types such as the A320, B737, CRJ, E190, etc.
- Wide-body jets include types such as the B787, B777, A340, A330, etc.

YVR has always been open 24 hours a day, including when the airport was managed by Transport Canada prior to the transfer to the Airport Authority in 1992. Figure 5 illustrates the annual night-time runway movements at YVR for the years 1989 to 2016. In 2016, the number of night-time movements increased by 16% compared to the previous year. While this equates to an average of 3 additional movements per night between the hours of midnight and 6:00 AM, night-time movements in 2016 remained below the peak years in 1999 and 2000.

FIGURE 5: Annual Night-time Movements at YVR, 1989-2016



OPERATIONAL SNAPSHOT – JET FLEET MIX BY NOISE CERTIFICATION

The International Civil Aviation Organization (“ICAO”) is an agency of the United Nations and establishes principles and techniques for the planning and development of international air transportation to ensure safe and orderly growth. The ICAO Committee on Aviation Environmental Protection (“CAEP”) prescribes standards for noise with the goal of promoting reduction at the source. These standards are contained in *Annex 16: Volume I Environmental Protection - Aircraft Noise* and categorize jet aircraft as either Chapter 2, Chapter 3 or Chapter 4 depending on three measured noise levels (take-off, landing, and sideline) obtained during prototype development⁵.

A new noise standard was confirmed at the 9th meeting of CAEP in February 2013. This new standard, Chapter 14, will apply to new large aircraft types certified after 2017 and to aircraft

⁵ To reduce aircraft noise exposure on communities, the Government of Canada legislated the phase-out of Chapter 2 jet aircraft over 34,000kg from operation in Canada by the year 2002. These aircraft are no longer permitted to operate in Canada and were either retired from operation or modified to meet Chapter 3 standards. A few exemptions were granted to aircraft operating from airfields in northern Canada.

less than 55 tonnes after 2020. To meet the Chapter 14 standard, aircraft must be at least 7 EPNdB (Effective Perceived Noise in Decibels) quieter than the current Chapter 4 standard. This reduction is cumulative over three measurements points: take-off, landing and sideline.

An analysis was performed on jet operations occurring in 2016 to determine the percentage of Chapter 3 and Chapter 4 movements. Table 4 below presents the results of the analysis, and provides an additional breakdown by the Gross Take-off Weight ("GTOW") of the aircraft. In 2016, 93% of all jet aircraft operating at YVR met Chapter 4 noise standards.

TABLE 4: ICAO Noise Certification of Jet Operations at YVR, 2016

ICAO Noise Certification	All Jet Aircraft	GTOW less than 34,000kg (n~11,380)	GTOW greater than or equal to 34,000kg	
			Narrow Body (n~103,220)	Wide Body (n~34,900)
Chapter 3	7%	19%	8%	1%
Chapter 4	93%	81%	92%	99%

Approximately 94% of the jet operations occurring between the night time hours between midnight and 6:00 AM are with Chapter 4 noise certified aircraft.

The aviation industry puts tremendous effort to reducing impacts from noise and emissions. Over the years, airlines worldwide have invested billions to upgrade their fleet to reduce both noise and emissions. Aircraft operating today are approximately 30 dB quieter (or a 90% reduction in noise footprint area) as compared to original commercial jet aircraft. Airlines in Canada have invested in new modern aircraft and are known to have one of the youngest fleets in the world.

AIR TRAFFIC FLOW

YVR has two parallel runways and a crosswind runway. The south runway (08R/26L) and north runway (08L/26R), are aligned in an east-west direction with magnetic headings of 083° and 263°. The crosswind runway (13/31) is oriented in a northwest and southeast direction with magnetic headings of 125° and 305°.

For safety reasons, aircraft must take-off and land into the wind. The predominant winds at YVR are typically in an easterly or westerly direction and are in line with the two main parallel runways. Air traffic patterns over the Lower Mainland are highly dependent on which runway is active as the aircraft flight routes will change to accommodate different arrival and departures paths associated with each runway. Figure 6 and 7 illustrate typical flight patterns of YVR aircraft associated with the runway direction over a four-hour period. The green tracks are aircraft departing from YVR, and the red tracks are aircraft arriving into YVR.

FIGURE 6: Sample YVR Flight Tracks – Westerly Traffic Flow

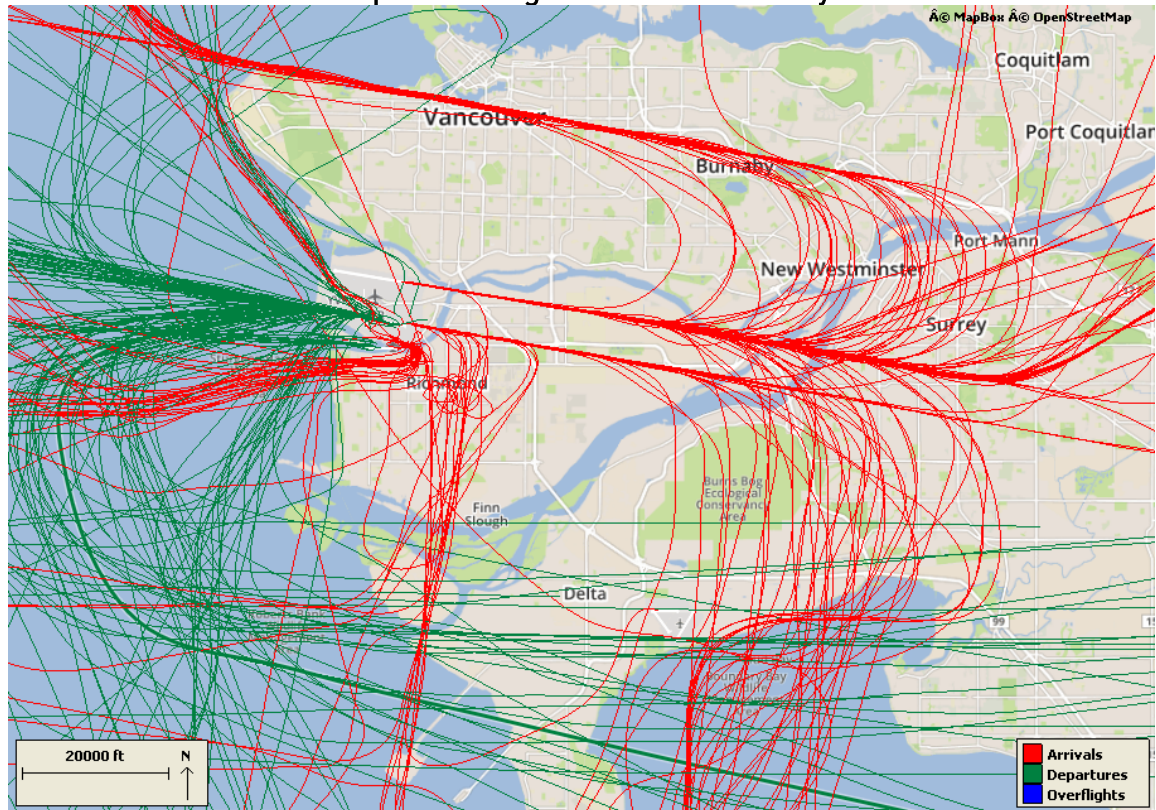
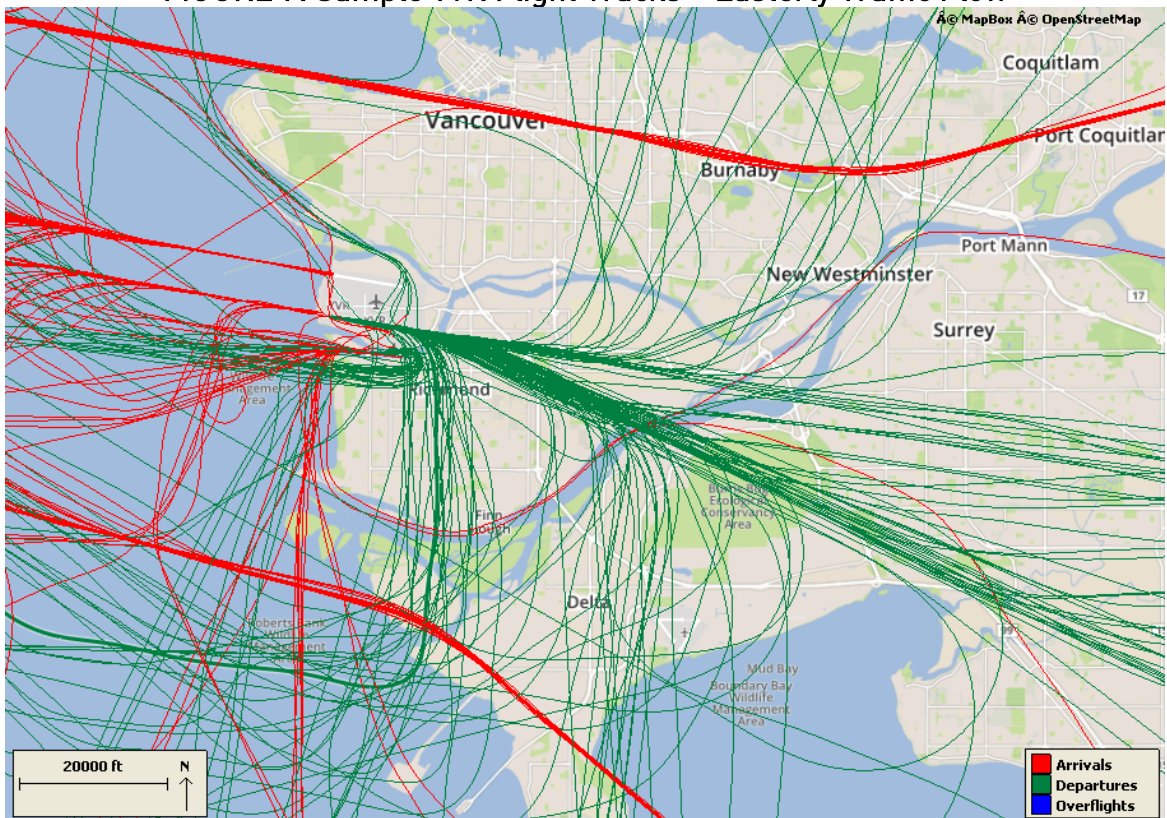


FIGURE 7: Sample YVR Flight Tracks – Easterly Traffic Flow

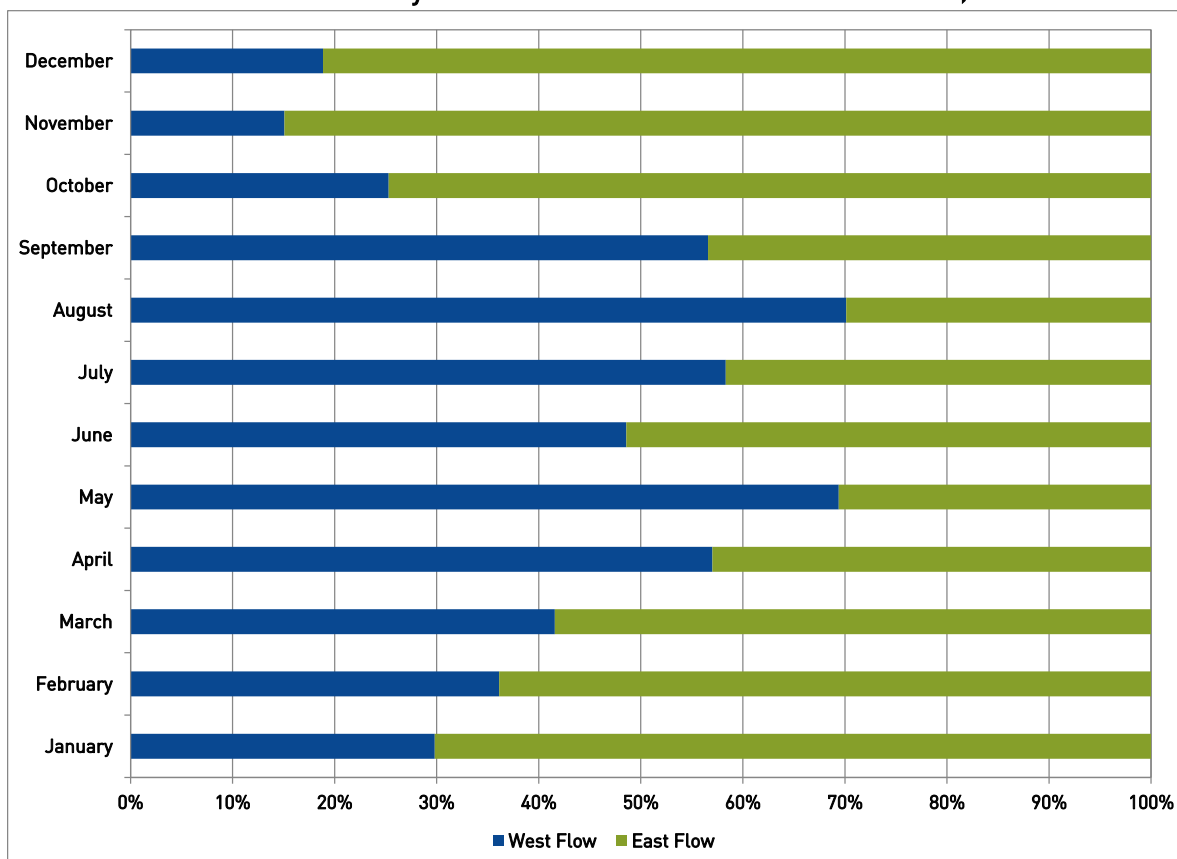


Based on historical observations, traffic flow in an easterly direction (runway 08L and 08R in use) are more common during the fall and winter months, and traffic flow in a westerly direction (runway 26L and 26R in use) are more common during the spring and summer months.

The published Noise Abatement Procedures for YVR prescribes westerly flow of traffic as the preferred mode of operation to reduce noise exposure on the community as this puts departures, the noisiest type of operation, over the Strait of Georgia. During the night-time hours, when the winds are calm, NAV CANADA will attempt to accommodate two-way flow by keeping both arriving and departing aircraft over the Strait of Georgia in an effort to minimize over-flights and noise on the community. However, the use of two-way flow is dependent on traffic volume and weather conditions and cannot be used all the time.

Figure 8 illustrates the monthly distribution between easterly and westerly flow on the parallel runways. As stated above, the seasonal trends can be observed with more dominant east flow during the fall and winter months and more dominant west flow during the spring and summer months. Overall, the wind conditions were balanced with 45% westerly flow and 55% easterly flow in 2016.

FIGURE 8: Monthly Distribution of Air Traffic Flow at YVR, 2016



RUNWAY USE

As mentioned in the previous section, the prevailing winds at the airport are typically from the west or the east. Therefore, the parallel runways, south runway (08R/26L) and north runway (08L/26R), are the primary runways in use at YVR, and the crosswind runway (13/31) is used infrequently during strong crosswind conditions. Figure 9 and 10 illustrate the percentage of runway distribution for arrival and departures in 2016.

The south runway is YVR's main 24-hour runway while the north runway is normally closed between the hours of 10:00 PM and 7:00 AM (except for emergencies, weather, and airfield maintenance activities). Between 7:00 AM and 10:00 PM, the north runway is used primarily for landings except during peak periods when departures may occur to reduce delays, or during emergencies and snow events.

Every year, YVR closes the south runway at night for multiple weeks for routine maintenance and project work, and aircraft are diverted to the north runway. In 2016, along with the annual routine maintenance, the Airport Authority completed the second of a three-year project to construct Runway End Safety Areas (RESAs) on the south runway. To accommodate this work, the north runway was used during the night-time hours 6 nights a week for approximately 19 weeks.

As also mentioned, the published Noise Abatement Procedures for YVR specify westerly flow (Runway 26 flow) as the preferred mode of operation weather permitting, as this places noisy departure operations over the Strait of Georgia. In 2016, 45% of take-offs occurred on Runway 26L and 26R as shown in Figure 10.

FIGURE 9: Runway Arrival Distribution, 2016



FIGURE 10: Runway Departure Distribution, 2016



RUN-UPS

Transport Canada requires regular maintenance of aircraft to ensure safe operations. Engine run-ups are performed as part of maintenance work and involve running the engines at various power settings for a period of time to stress components and to simulate flight conditions. This ensures work has been done properly and that the aircraft is safe to return to service.

YVR RUN-UP DIRECTIVES AND PROCEDURES

In an effort to reduce community noise exposure from run-ups, the Airport Authority maintains directives and procedures that prescribe how, when, and where run-ups can be performed. Aircraft operators must request permission from the Airport Authority prior to performing a run-up. Approved run-ups are assigned a location and heading to ensure safety and to minimize noise impacts on surrounding communities. All maintenance run-ups are logged, and these records are routinely analyzed to track run-up activities and identify trends.

YVR RUN-UP ACTIVITY

Over the last five years, the number of run-ups performed at YVR has decreased. This can be attributed to the advancement of aircraft technologies that require less run-ups. In 2016, there was a 1% decrease in the number of run-ups performed at YVR compared to 2015. Table 5 provides the number of run-ups performed each year at YVR for the time period of 2012-2016.

TABLE 5: Number of Run-ups Performed at YVR, 2012-2016

Year	Number of Approved Run-ups
2012	5,706
2013	5,157
2014	4,916
2015	4,653
2016	4,584

Operators performing run-ups can be divided into two distinct areas of the airfield - those located on the north airfield, and those located on the south airfield, with the south runway acting as the dividing line. In 2016, north airfield operators accounted for approximately 42% of all run-up activities at YVR and south airfield operators accounted for the remaining 58%. The run-ups by south airfield operators are generally performed on propeller aircraft, as many operators of propeller aircraft have their maintenance facilities on the south airfield.

In general, there are three different power settings associated with run-ups: idle; above idle; and, full power. Full power run-ups are considered the noisiest because the engine is operated

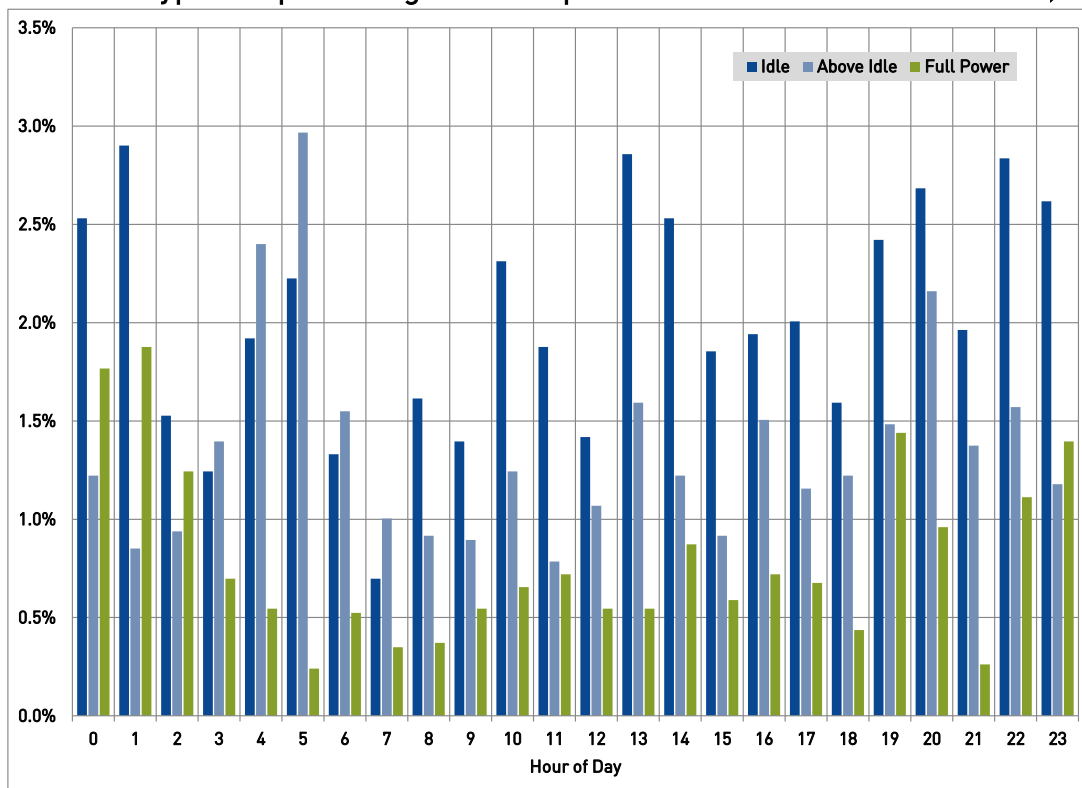
at maximum power. Run-ups performed at full power are very infrequent and are often shorter in duration when compared to idle and above idle run-ups. This is due to the increased wear on the engines and fuel consumption associated with running engines at full power for prolonged periods. Table 6 provides a breakdown of run-up types and per cent total at YVR for 2016.

TABLE 6: Run-up Type (by power setting) Distribution, 2016

Run-up Category	Percent Total of Runs
Idle	48%
Above Idle	33%
Full Power	19%

Run-ups are performed at all times of the day. Figure 11 provides a percentage breakdown for all run-ups (n=100%) carried out at YVR in 2016 by power setting and hour of the day. Because most aircraft are flying during the day, maintenance work on aircraft are often performed at night when the maintenance crews have access to the aircraft, and the associated run-up also occurs at night to ensure the aircraft is airworthy to return to service in the morning. However, as illustrated, operators are consistently busy throughout the day with run-ups being carried out at all times of the day.

FIGURE 11: Type and percentage of run-ups conducted for each hour at YVR, 2016



GROUND RUN-UP ENCLOSURE (GRE)

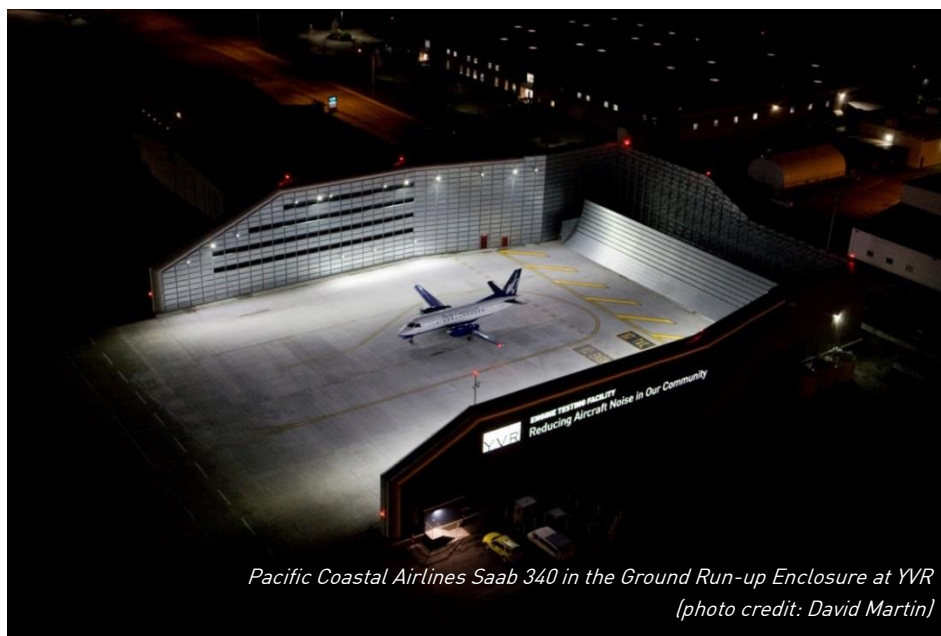
To reduce noise from the high number of propeller run-ups by operators located on the south airfield, the Airport Authority constructed Canada's first Ground Run-up Enclosure (GRE) and the facility was opened in January 2012. The GRE is designed to provide an average of 15 dBA noise reduction, and residents to the south of YVR can experience a 50% reduction in run-up noise.

The GRE facility is the preferred location for high power run-ups on the south airfield. In 2016, there were approximately 1,360 high power run-ups performed by south airfield operators, with 76% of these performed in the GRE. Table 7 provides a more detailed breakdown of high power run-ups on the south airfield and their location in comparison with the GRE.

TABLE 7: South Airfield High Power Run-up Locations, 2016

Power Setting	Location	Approx. % of South Airfield Run-ups
Above Idle	GRE	55%
	Apron III	44%
	Apron II	2%
Full Power	GRE	95%
	Apron III	4%
	Other	<1%

The GRE has reduced noise in the community and has been a great success with operators, who often request use of the facility for their run-ups due to its safe and controlled setting.



*Pacific Coastal Airlines Saab 340 in the Ground Run-up Enclosure at YVR
(photo credit: David Martin)*

NOISE CONCERNS

One of the goals of the YVR Aeronautical Noise Management Program is to provide the community with up-to-date information on noise management efforts and initiatives. The community is able to contact the Airport Authority with their questions and concerns through one of the following means:

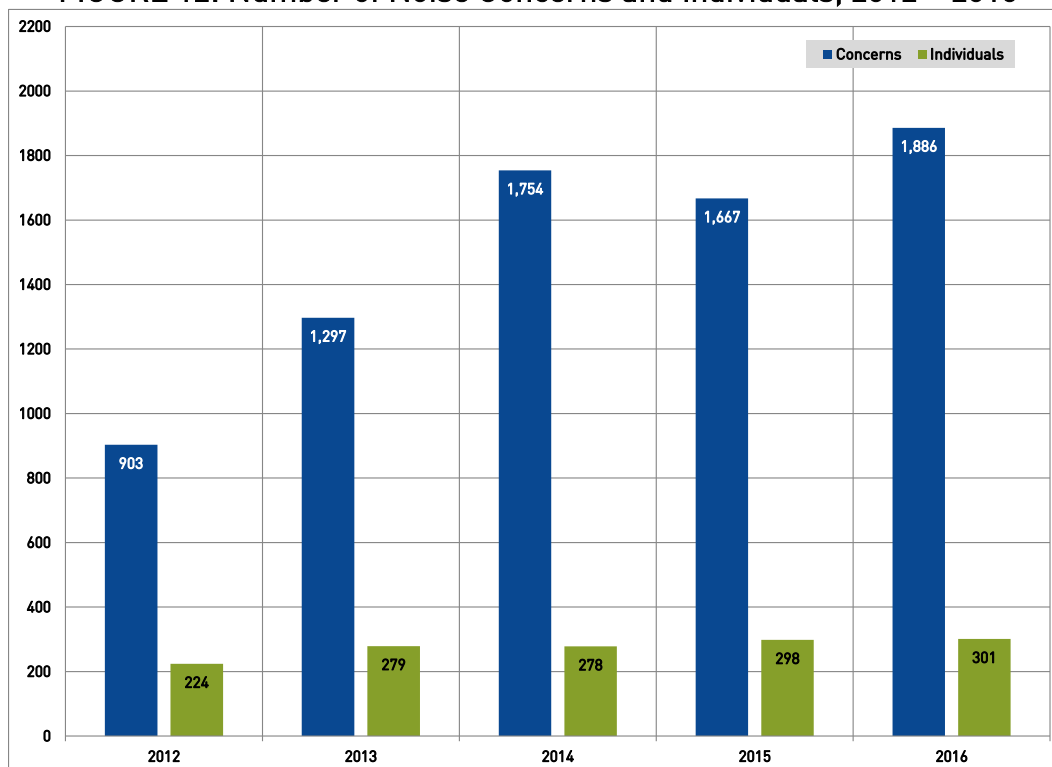
- Dedicated e-mail (noise@yvr.ca)
- Real-time flight and noise tracking system ([WebTrak](#))
- YVR Noise Information Line (604-207-7097), 24-hours.

Information provided by the community and investigation results are logged in a database, which is used to identify trends. The YVR Aeronautical Noise Management Committee is provided a summary of complaints at each meeting and will review and discuss issues.

NUMBER OF CONCERNS

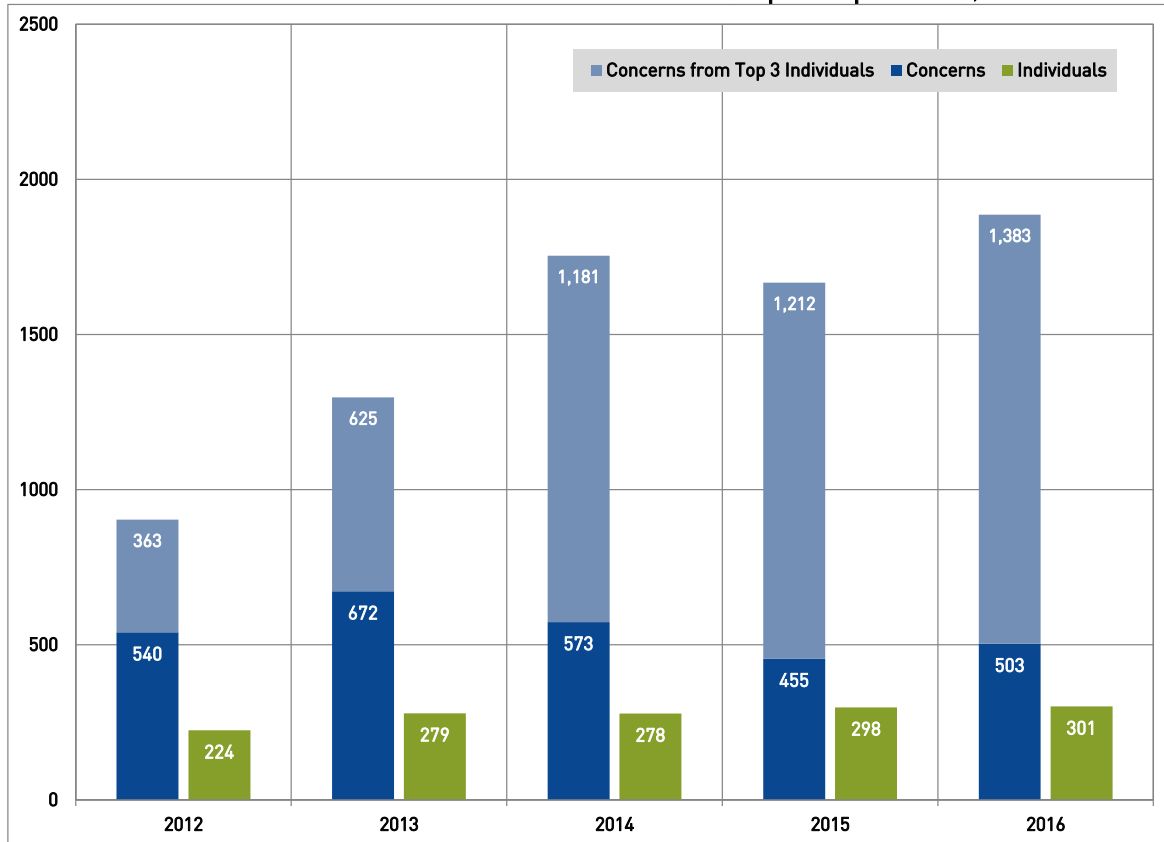
In 2016, the Airport Authority received 1,886 noise concerns from 301 individuals. This represents 13% increase in concerns and 1% increase in the number of individuals compared to 2015. Figure 12 presents a breakdown on the number of concerns and individuals for the past five years (2012-2016).

FIGURE 12: Number of Noise Concerns and Individuals, 2012 – 2016



Generally, there are a number of individuals who register multiple concerns throughout the year. In 2016, 73% (n=1,383) of all concerns were submitted by three individuals, with one person registering over 1,200 concerns. Figure 13 provides a further breakdown of the number of concerns and individuals between 2012 and 2016 by separating the number of concerns submitted by the top three individuals in each year.

FIGURE 13: Number of Concerns and Individuals (Top 3 Separated), 2012 - 2016



NOISE CONCERNS BY LOCATION

Whenever possible, individuals are asked to provide information on which city they live in to help determine where in the Lower Mainland concerns are originating from. Figure 14 shows the number of concerns and individuals for the various cities in the Lower Mainland.

FIGURE 14: Number of Concerns and Individuals by Location, 2016

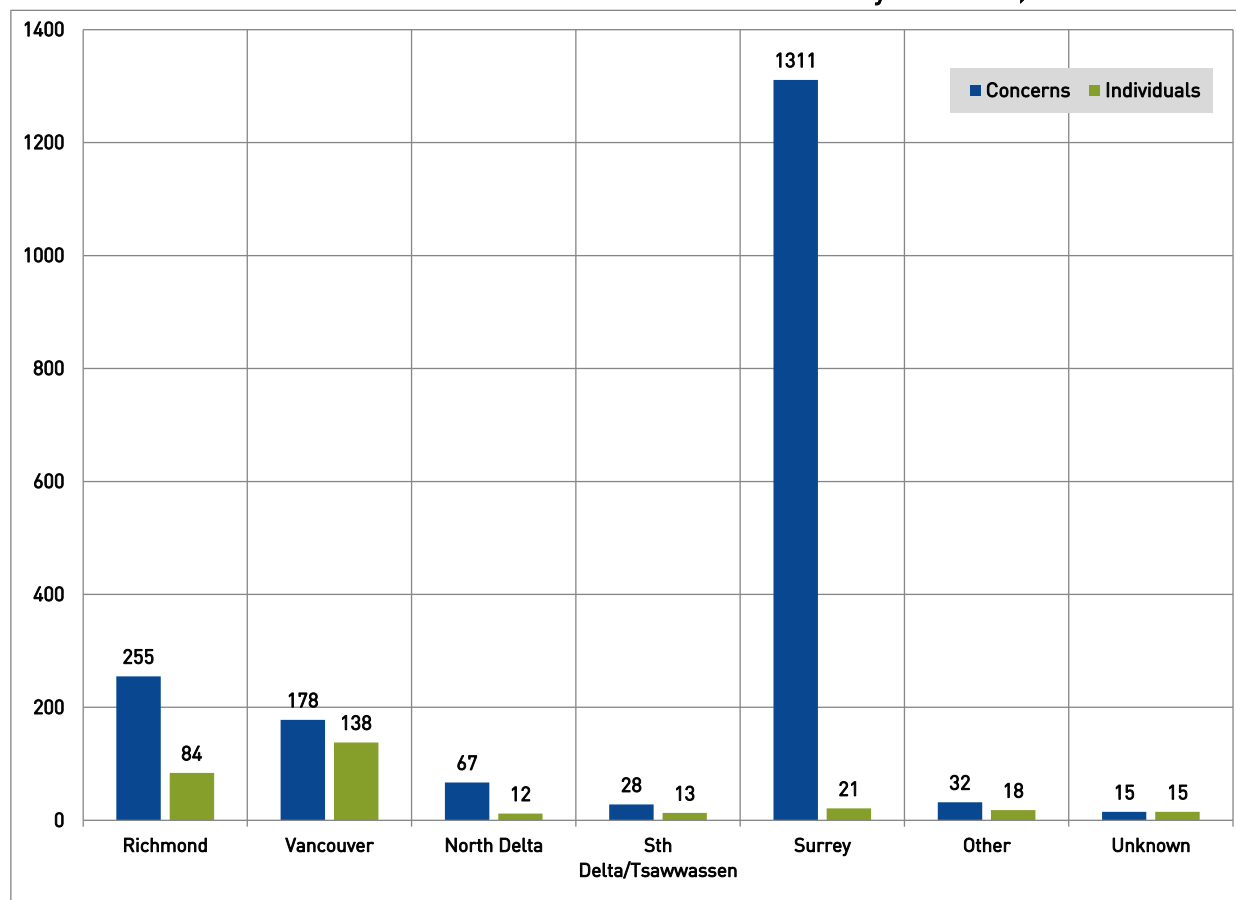


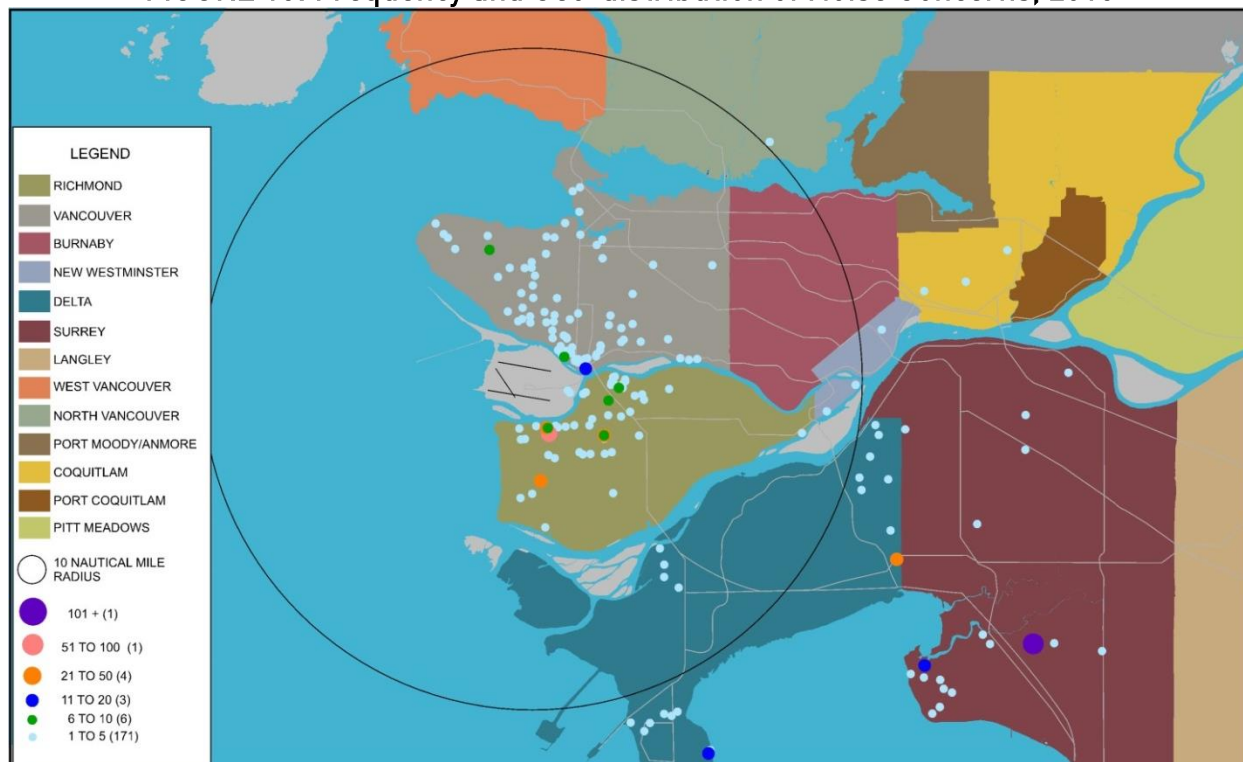
Figure 15 represents the geo-distribution of noise concerns in the Lower Mainland in 2016 based on the postal code reference. Locations closer to the airport generally exhibit a greater density of noise concerns due to the lower altitude of aircraft and regularity of aircraft activity in these locations.

Figure 16 represents the geo-distribution and the frequency of concerns in the Lower Mainland from 2016. The size of each dot represents the volume of concerns originating from that postal code. As illustrated, some of the most frequent individuals reside in areas well outside a 10 nautical mile (nm) radius from the airport. Aircraft noise concerns from these areas are generally related to the air traffic routing over populated areas.

FIGURE 15: Geo-distribution of Noise Concerns, 2016



FIGURE 16: Frequency and Geo-distribution of Noise Concerns, 2016

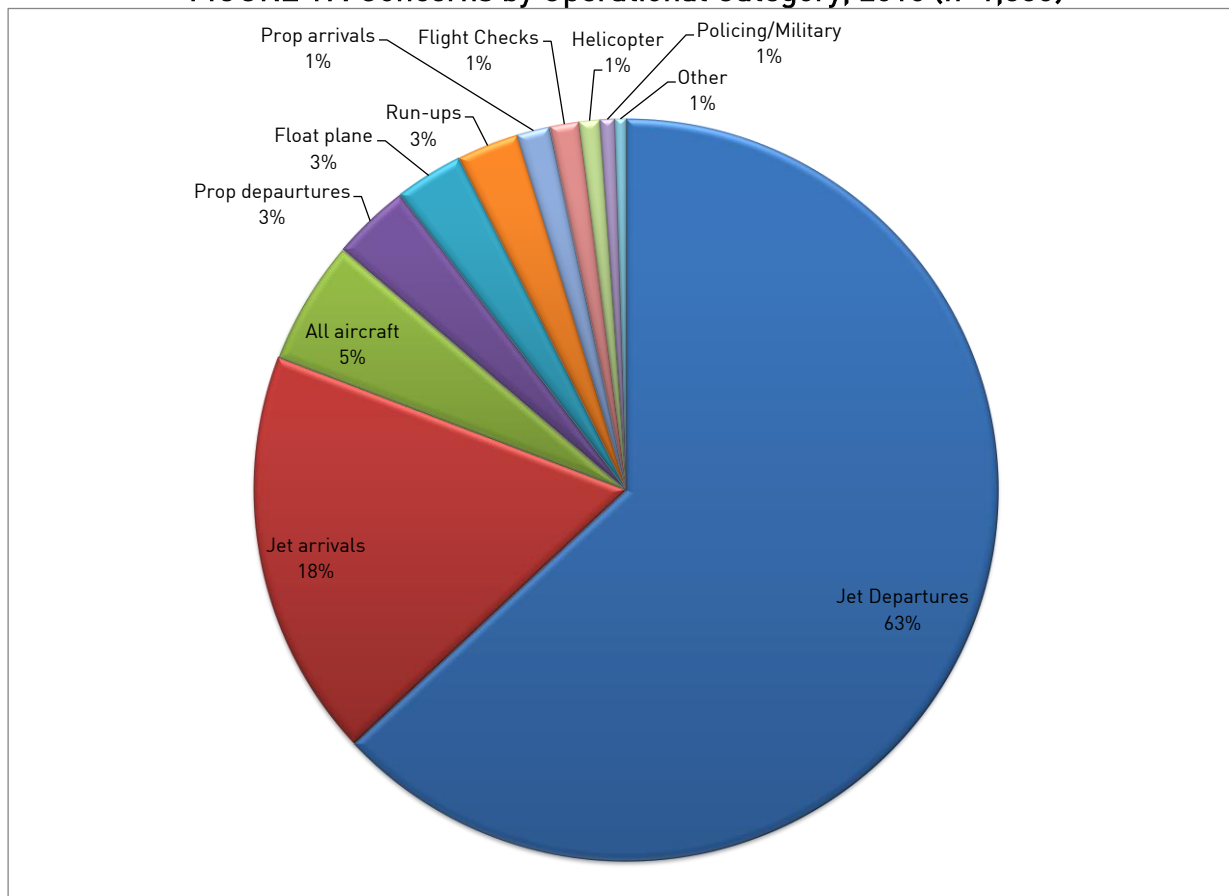


NOISE CONCERN BY OPERATION TYPE

When reporting noise concerns, individuals generally provide details of date, time, and location of the noise event. Based on the information provided, each concern is categorized into an operation type such as jet departure, jet arrival, helicopter and run-ups. In some cases, the information provided by the individual is not sufficient to categorize the concern to a specific operation. In these instances, Airport Authority staff will review flight tracks and procedures to best categorize the nature of the concern. The nature of concerns varies greatly and often depends on where the individual is located with respect to the airport and flight paths. General concerns that cannot be matched against a specific operation type are categorized as “All aircraft”.

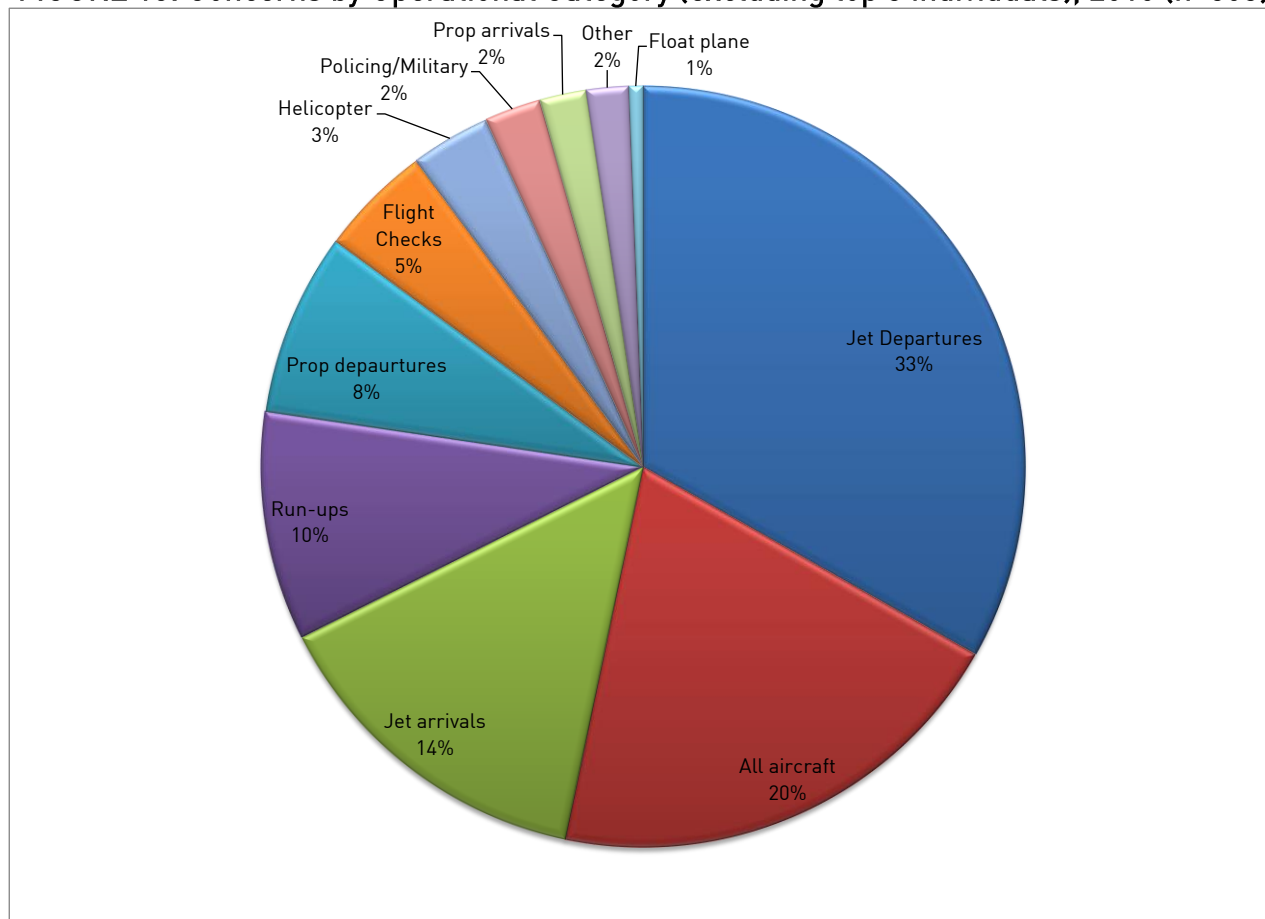
Figure 17 shows a breakdown of all noise concerns received in 2016 by operational category. As illustrated, majority of the concerns were related to jet departures (63%) and jet arrivals (18%) in 2016. Approximately 80% of these concerns were, however, submitted by one individual located outside the 10 nm radius from the airport, mostly related to departure and arrival jet aircraft routing over populated areas.

FIGURE 17: Concerns by Operational Category, 2016 (n=1,886)



When a small number of individuals register multiple concerns, this can heavily influence the analysis. Therefore, to better understand the nature and trends of concerns from the other individuals, further analysis was done with the dataset that excluded the 1,383 concerns from the three individuals. Figure 18 illustrates a breakdown of these concerns by operation type.

FIGURE 18: Concerns by Operational Category (excluding top 3 individuals), 2016 (n=503)



Jet departures remains the top operational category, and approximately 80% of these concerns originated from residents in the City of Richmond and City of Vancouver, where areas are exposed to jet aircraft take-off activities at low altitudes. The majority of concerns in this category from individuals in the City of Vancouver are associated with departures on the north runway during periods when the south runway is closed for maintenance or emergencies.

Approximately 20% of the concerns were of a general nature with no specific operations referenced by the individuals, and these concerns were counted in the “All Aircraft” category. Jet arrivals accounted for 14% of the concerns, mostly regarding arrival routes over populated areas and low flying.

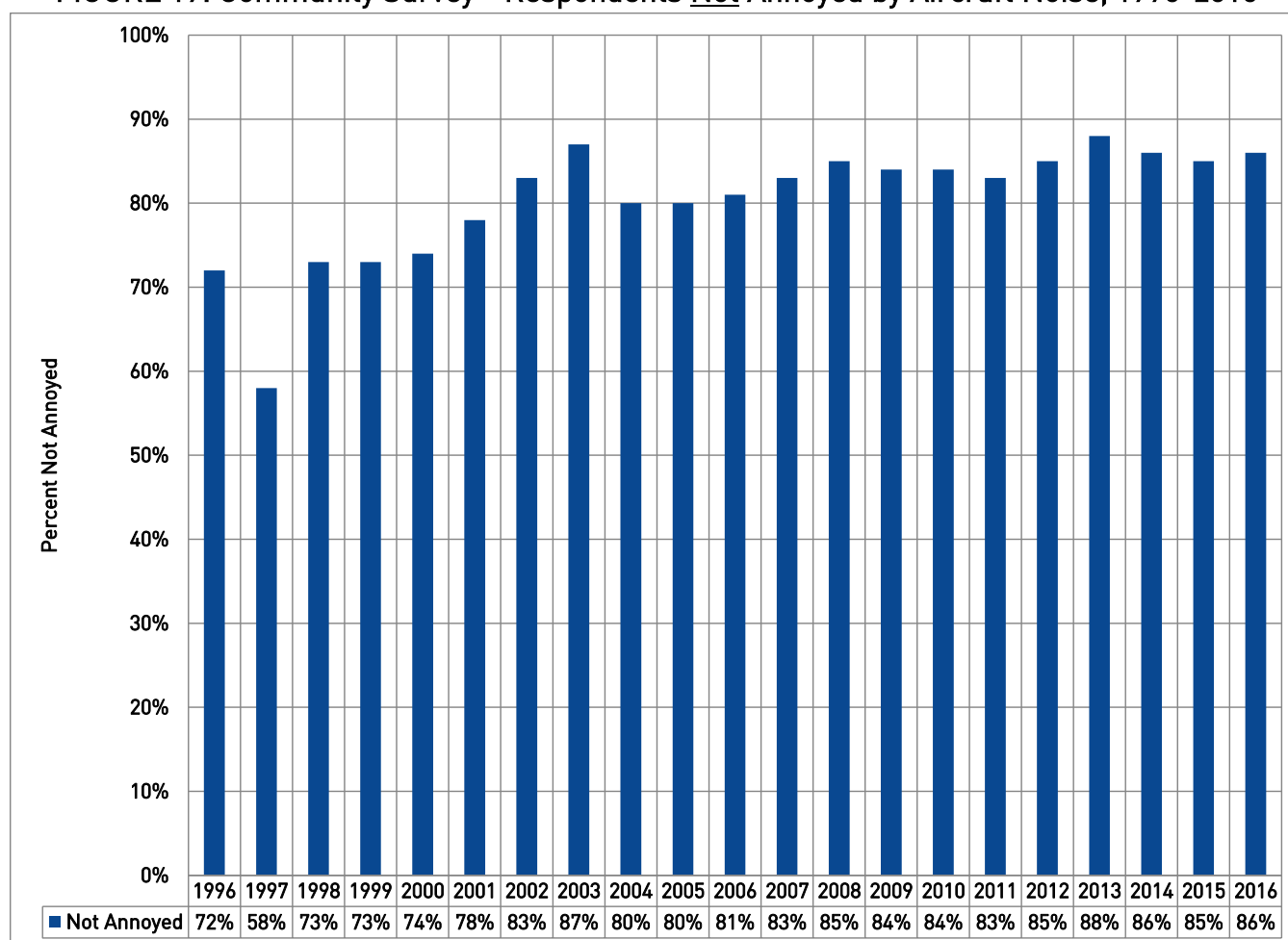
Concerns associated with run-ups made up 10% of the concerns. The majority of these concerns were submitted by a small number of individuals living to the south of the airport in close proximity to where a number of operators maintain their aircraft.

COMMUNITY SURVEY

Since the mid-1990s, the Airport Authority has commissioned a third party survey to track public attitudes and opinions about YVR on a number of topics including aircraft noise. This community survey represents the opinions of approximately 1,000 residents from across communities of the Lower Mainland and provides one means to gauge the level of community annoyance triggered by aircraft noise.

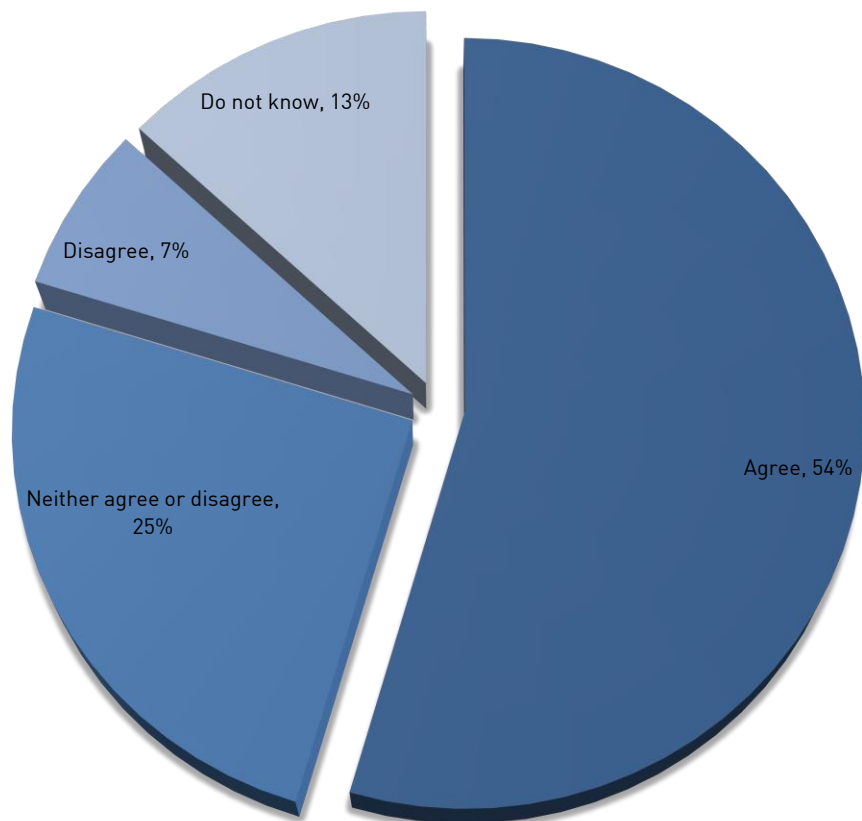
When asked, “*While you have been at home during the past year, have you been annoyed by aircraft noise in your neighbourhood?*” approximately 86% of the respondents in 2016 stated that they were not annoyed by aircraft noise. Figure 19 illustrates the trend since 1996.

FIGURE 19: Community Survey - Respondents Not Annoyed by Aircraft Noise, 1996-2016



In 2016, the community survey respondents were also asked to rate whether they agree or disagree with the statement “YVR keeps aircraft noise in my neighbourhood at an acceptable level”. In response to this question, 54% of the respondents agreed with the statement whereas 7% of the respondents disagreed. Figure 20 provides the breakdown of responses.

FIGURE 20: Community Survey - Response to the YVR Noise Management Effort



NOISE MONITORING DATA

The monitoring of noise levels and aircraft activity in the vicinity of the airport is a major component of the YVR Aeronautical Noise Management Program. To achieve this, the Airport Authority uses a Brüel & Kjær Aircraft Noise & Operations Monitoring System (“ANOMS”), which allows for an objective assessment of aircraft noise levels in the surrounding communities. The system also allows for the identification of trends and checks for compliance with published procedures.

ANOMS combines noise data collected at Noise Monitoring Terminals (“NMT”) with radar flight tracking data from NAV CANADA and mapping data from a Geographic Information System. ANOMS correlates flight track data with noise monitoring data collected at each NMT, which then allows an understanding of the contribution of aircraft noise at each site. Figure 21 illustrates the NMT network and their relationship to runways at YVR. In 2009, the Airport Authority replaced and upgraded all hardware at the NMT sites and expanded the network from 16 to 20 NMTs.

FIGURE 21: NMT Locations in the Lower Mainland



ANNUAL AVERAGE NOISE LEVELS (LEQ)

There are numerous metrics available to assess noise. One common metric for community noise assessment is the equivalent sound level, or average noise level (“Leq”) measured over a given period of time. Table 8 presents the annual average Leq, measured in units of A-weighted decibel or dBA, at each NMT location for the last five years. The average noise levels, presented below, include contributions from all sources, including aircraft, motor vehicles, people, lawn mower, barking dogs, etc.

TABLE 8: Annual Average Noise Level (in dBA), 2012-2016

YEAR	NMT# 1	NMT# 2	NMT# 3	NMT# 4	NMT# 5	NMT# 6	NMT# 7	NMT# 8	NMT# 9	NMT# 10
2012	-	65.5	53.5	60.9	58.8	58.2	-	52.2	50.7	54.0
2013	-	65.8	53.4	60.1	58.6	60.1	-	53.0	51.0	55.3
2014	-	65.0	52.7	60.6	58.5	69.4	-	55.4	50.3	54.4
2015	61.4	65.1	52.7	60.3	58.4	61.7	58.4	52.0	50.1	54.3
2016	61.2	65.3	53.0	62.4	58.4	58.1	58.4	55.8	51.3	56.7

YEAR	NMT# 11	NMT# 12	NMT# 13	NMT# 14	NMT# 15	NMT# 16	NMT# 17	NMT# 18	NMT# 19	NMT# 20
2012	60.1	63.9	59.5	55.1	52.9	54.9	53.5	53.9	53.9	53.4
2013	61.2	67.4	60.6	55.3	52.9	55.3	53.7	57.8	53.3	54.4
2014	60.8	74.7	61.0	65.7	53.1	54.5	54.0	57.5	55.7	54.3
2015	61.4	65.1	61.5	64.1	53.5	56.3	56.2	54.7	55.9	53.0
2016	60.6	66.9	61.4	56.1	53.8	54.6	54.1	53.8	56.3	56.1

SINGLE EVENT NOISE LEVEL

Another metric used to assess noise is the single event noise level (“SEL”), measured in dBA. For an aircraft fly-over, either a landing or take-off, the SEL represents the total acoustic energy above a prescribed reference threshold. In general, the SEL is typically 10 dBA greater than the maximum noise level experienced during the aircraft fly-over. The primary use of the SEL is to provide a comparison of noise events with different noise levels and durations.

While reference thresholds are set individually at each NMT according to the ambient noise levels in the area, thresholds are typically set between 65 and 70 dBA during the day (7:00 AM – 10:00 PM) and between 55 and 60 dBA.

ANOMS categorizes noise events into types: correlated and uncorrelated. Correlated events are those associated with aircraft and uncorrelated events are those associated with other sound sources in the community. For NMTs located close to flight paths, noise events are

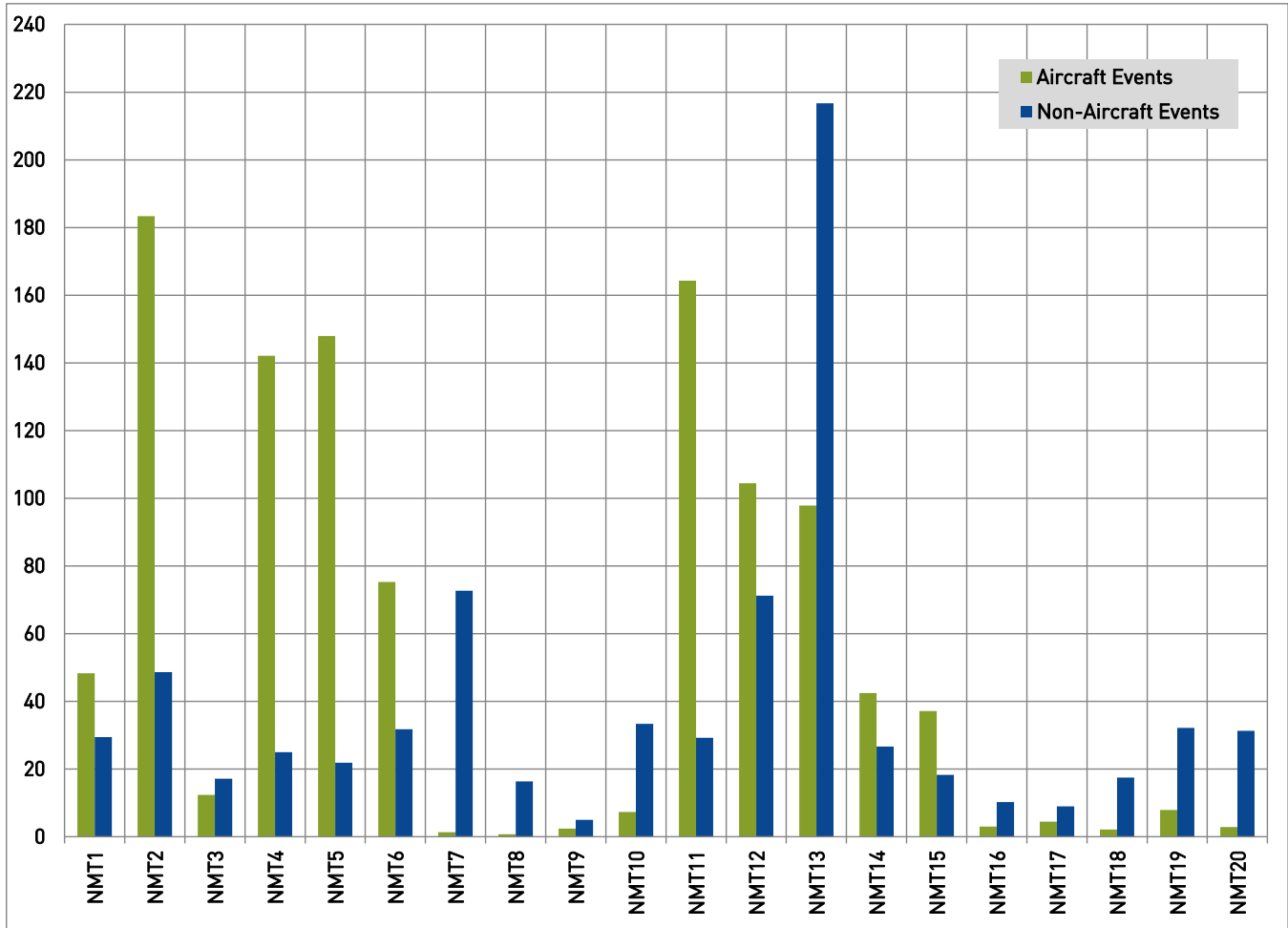
primarily made up of aircraft related events, whereas noise events at NMTs located farther away from the airport and flight path are primarily made up of non-aircraft related events.

Table 9 presents the 2016 daily average number of aircraft and non-aircraft noise events with the SEL level above 70 dBA at each of the NMT locations. Figure 22 presents this same information graphically.

TABLE 9: Average Daily Number of Noise Events at NMTs, 2016

NMT #	Name	Location	Average number of DAILY noise events \geq 70 dBA		
			Aircraft	Non-Aircraft	Total
1	Richmond Olympic Oval	6111 River Rd., Richmond	48	29	77
2	Airside Burkeville	Templeton St., Richmond	183	49	232
3	Lynas Lane Park	Lynas Lane & Walton Rd., Richmond	12	17	29
4	Tomsett Elementary	Odlin Rd. and No. 4 Rd., Richmond	142	25	167
5	Bath Slough	Bath Rd. & Bath Slough, Richmond	148	22	170
6	Outer Marker	Westminster Hwy & No. 7 Rd., Richmond	75	32	107
7	Crofton School	W41st & Blenheim St., Vancouver	1	73	74
8	McKechie School	W59th & Maple St., Vancouver	1	16	17
9	UBC	Northwest Marine Dr., Vancouver	2	5	7
10	Marpole	W67th & Cartier St., Vancouver	7	33	40
11	Bridgeport	No. 4 Rd. & Finlayson Dr., Richmond	164	29	193
12	West Sea Island	Airside YVR, Richmond	104	71	175
13	North Sea Island	Ferguson Rd., Richmond	98	217	315
14	Annieville-Delview Second	9111-116th St., Delta	42	27	69
15	Alex Fraser Bridge	North Delta Rec. Ctr. 11415-84th Ave., Delta	37	18	55
16	Burnaby - St. Francis	6610 Balmoral St., Burnaby	3	10	13
17	Maple Lane Elementary	Alouette Dr. & Tweedsmuir Ave., Richmond	4	9	13
18	South Delta - Tsawwassen	53rd Street & 8A Ave., Delta	2	17	19
19	North Surrey	82A Ave. & 146th St., Surrey	8	32	40
20	South Surrey	20th Ave. & Ocean Forest Dr., Surrey	3	31	34

FIGURE 22: Average Daily Number of Noise Events at NMTs, 2016



ENVIRONMENT – YVR Noise Management

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For questions regarding this report or aircraft noise, please contact us at the following:

E-mail: noise@yvr.ca

[WebTrak](#)

YVR Noise Information Line: 604- 207-7097

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Note on Reported Figures and Data:

The Airport Authority receives aircraft operations data from NAV CANADA. This data includes daily aircraft arrivals and departures at YVR as well as aircraft transiting through the Vancouver Control Zone. Every effort is made to verify and correct anomalies in the dataset, and numbers stated in this report may vary slightly from those reported by others.

Version 1.00

- Apr 26, 2017 -

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