Toronto Pearson International Airport
Decreasing Noise & Saving Fuel
On the Standard Terminal Arrival Routes¹

A Submission to

The Honourable Lisa Raitt, M.P.
Minister of Transport

Prepared on behalf of the
Toronto Aviation Noise Group

By

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November 14, 2014

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Toronto Pearson International Airport

Decreasing Noise & Saving Fuel
On the Standard Terminal Arrival Routes (STARs)

Executive Summary

This paper discusses:
- the major factors in noise generation by jet aircraft caused by systemic processes in the arrival phase of flight, specifically with respect to traffic patterns around Toronto Pearson International Airport
- the cost of increased fuel burn associated with those same processes
- solutions that will reduce noise and decrease fuel consumption and carbon emissions without shifting the existing noise somewhere else. These solutions will reduce noise in Milton, Oakville, Halton as well as Markham and the target area in east Toronto.

The phased approach to change outlined in this document will allow the most immediate improvement in noise reduction to affected areas while details of the second phase are being tested and finalized by Nav Canada.

Phase 1 recommendations are simply extensions of current practices that happen occasionally as a result of air traffic controller intervention and could be handled with NOTAM (Notice to Airmen) changes while official STAR charts are amended. Some altitude changes to STARS have already been handled by NOTAM since the current STARS were issued.

Phase 1 Benefits

- Reduce gross noise generated by decreased use of speedbrakes, flaps and engine power
- Reduce noise reaching the ground due to geometric reduction and atmospheric attenuation
- Allow continuous descents from 6000ft. (CDA)
- Reduce fuel burn, carbon emissions and flight time
- Result in no “shifting” of the noise to other residents
- Save approximately $3 million per year in fuel for the airlines

Phase 2 recommends a routing that would pass over the area east of the Don Valley. However, due to processes introduced in Phase 1, noise impact would be minimal and in an area with a greater apartment and condominium population likely to be less affected by aviation noise.

Phase 2 Benefits

- Reduce total track miles flown
- Reduce track miles flown over populated areas
- Reduce fuel burn, carbon emissions and time
- Allow departures to climb directly to cruise altitude
- Save approx. $20 million/year in fuel and flight time savings for the airlines

All suggested altitudes and routings recommended in this document have been tested in a Transport Canada certified Level D Boeing 787 Full Flight Simulator by a regular line Captain (the author) accompanied by a long term Check Captain. In addition the author had an opportunity to actually fly a tight base procedure from the altitudes, configurations and speeds recommended and was able to do so smoothly, using normal techniques, without speedbrakes, without a level segment, rolling out on final approach, right on the glideslope.

Fuel burn predictions are taken from Boeing 787 performance data (Appendix 1) Cost savings are calculated in conjunction with fuel burn and aircraft movement estimates. No actual aircraft movement data was available to the author but estimates should be accurate within 20%

According to Nav Canada, major drivers to the airspace review that resulted in these STARS were to reduce fuel burn, carbon emissions and travel times. The recommendations in this submission would further improve performance on these measures, as well as substantially reduce the noise impact on residential areas of the city.

About the Author

David Inch is an airline captain with 35 years of service in medium and large transport aircraft in domestic and international operations. He has a strong user's understanding of air traffic control procedures in many countries under ICAO purview. Captain Inch is a graduate of the Aviation Flight and Technology program at Seneca College, is a Six Sigma Green Belt and has held the position of Manager, Process and Automation at a major Canadian airline. He is also the President of Aloft Technologies Inc., a software developer specializing in the aviation sector.

Shortly after the implementation of the new STARs in early 2012 he contacted Nav Canada and recommended post-implementation amendments to the altitudes and aircraft speeds of the STARs. Met with stonewalling, he gave up the fight on his own. Captain Inch became aware of the Toronto Aviation Noise Group’s mission in September 2014 and contacted T.A.N.G to offer technical expertise so that, together, they could make supplementary submissions to the Minister of Transport based on aviation proficiency.

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Decreasing Noise & Saving Fuel
On the Standard Terminal Arrival Routes into Pearson International Airport

Introduction

This paper discusses the major factors in noise generation by jet aircraft caused by systemic processes in the arrival phase of flight, specifically with respect to traffic patterns around Toronto Pearson Airport. In addition, it addresses the cost of increased fuel burn associated with those same processes. For the most part, we know that cost is a major driver for change, so including fuel cost will encourage change to a greater degree than just a discussion of noise. Finally, it proposes solutions that will reduce noise and decrease fuel consumption and carbon emissions without just shifting the existing noise somewhere else.

Phase 1 recommendations are simple: change the altitude restrictions and speed on YYZ STARs, to:

- allow aircraft to stay higher and "clean" (flaps retracted) longer and at lower power
- decrease noise by more than 75% for many residents without increasing it for others.
- save almost $3 million per year in fuel
- create true CDA (Constant Descent Approaches): the lowest noise, most efficient approaches

Phase 2 includes more impactful changes to the STARs that would be to make routing changes for flights arriving on the FLINE and LINNG STARs. These changes would result in significant overfly and noise reduction implications. It is difficult to quantify the potential fuel savings without specific current flight data. However, it is estimated that, in conjunction with improvements in departure climb profiles that these changes would allow, these could save in excess of $10 million per year in fuel plus another $10 million in time costs.

Finally, there are safety related issues with regard to the proximity with which the current STARs place transport aircraft relative to recreational aircraft as well as the safety impact of the required restrictions adjacent to YYZ on recreational aircraft.

Overall, by implementing these changes, safety will be increased while fuel burn, noise and costs will decrease. At the risk of repeating myself, the solution proposed here reduces noise that gets to the ground... it doesn’t just move it somewhere else only to end up with a new group of impacted residents.

Recommendations herein will reduce noise and improve the quality of life for residents in Toronto, Markham, Oakville, Georgetown and Milton.
Noise created by YYZ STAR design and the root causes of noise

This discussion will attempt to identify the underlying factors to residential noise and excessive fuel burn caused by the current Standard Terminal Arrival Routes (STARs) currently in use in YYZ.

A lexicon is provided in Appendix H for those not familiar with all of the terms referred to.

All altitudes in this document are Above Sea Level (ASL) unless otherwise noted.

References to decibel levels have been avoided where possible because decibels are generally poorly understood. Instead, orders of magnitude are used so that the reader can appreciate the perceived difference in noise they will hear. Reading that it will be 75% quieter is easier to understand than saying that the sound pressure level will drop by 6 db.

Major factors that create or increase noise caused by transport aircraft include

- Altitude
- Flap setting
- Power setting
- Speedbrake use
- Geographic position

**Altitude:** Perceived sound decreases due to geometry with the square of distance. As a result, the perceived noise from an aircraft twice as far away is one quarter the value. **The noise reaching the ground created by an aircraft at 2500 ft. Above Ground (AGL) is four times louder than the noise of an aircraft at 5000 ft. AGL in the same configuration.** Since most of the GTA is about 500 ft. Above Sea Level, this comparison would hold true when comparing the difference in sound between aircraft flying at 5500 ft. ASL and 3000 ft. ASL.

In addition, there are atmospheric sound absorption, temperature gradient refraction and turbulence factors that reduce propagated noise. These factors have a greater opportunity for reduction effect on sound produced from higher altitudes. Aircraft flying below an inversion layer (more common in the morning) have noise enhanced (increased) by reflection off the inversion layer. The higher the aircraft, the greater the chance it will be above this layer.

Aircraft with engines at idle and flaps retracted (“clean”) descend at a rate of approximately 300 ft. per mile of flight. It could also be stated that aircraft descends 1000 ft. in 3 miles. These are rough rules of thumb used by pilots and controllers. Crossing restrictions on downwind legs of STARs in YYZ put aircraft well below this profile, causing them to descend to altitudes where they create much higher levels of ground level noise.
**Flap Setting:** Flaps create significant noise. Flaps extended to the first position can more than double the sound generated and each flap setting redoubles the total amount of noise. Flaps generate more noise than engines in level flight in a high-bypass modern aircraft\(^3\). Often, flap noise is confused with engine noise as flaps have a ripping effect on the air they pass through.

![Influence of flap deflection angle on predicted noise level](image)

**Figure 1**
Influence of flap deflection angle on predicted noise level\(^1\).

YYZ STARs unnecessarily force aircraft to slow down to speeds that require use of flaps. Figure 1 indicates that even a change between one position of flap to the next quadruples the sound level (6 db). The initial selection of flap (not illustrated) that allows aircraft to slow to 200 kts is even more dramatic because it involves both leading edge slats and trailing edge flaps and takes an aircraft from a relatively quiet aerodynamic state (flaps up or “clean”) to a “dirty” one,

**Power setting:** It is generally well understood that jet engines are quieter at low power and loud at high power. Aircraft flying slower do not necessarily use less power. The use of flaps caused by slower speed requires more power to overcome the additional drag, adding even more noise.

Aircraft in level flight use more power than those in descent.

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YYZ STARs cause aircraft to use more engine power at lower altitudes because they force use of flaps and early descents cause lengthy periods in level flight at low altitude often many miles from the airport.

**Speedbrake use:** Jet aircraft are “slippery”. By their very design, they are intended to move efficiently through the air. Speedbrakes are used as a temporary tool in jet aircraft to assist in slowing down or descending more quickly than normal by increasing drag. Speedbrakes are not as noisy as flaps, primarily because they are on top of the wing and sound is blanked somewhat by the wing itself, but they do create some noise, especially with flap extended.

The energy dissipated by speedbrakes is either as a result of power being unnecessarily applied prior to their use (usually a late point of descent) or speedbrake use must be made up by using power afterwards to maintain level flight. In both cases, speedbrake use is often a failure of either the system or poor planning by the pilot. Often poor planning by pilots is the result of lack of information in combination with a desire to "be ready" for situations which may or may not come to pass, like early turn-ins. If the early turn does not come to pass, the aircraft is low and slow with flaps extended for an extended period of time. So communication is important to avoid this situation.

Aircraft normally slow down at the rate of 10 kts for every mile flown. The use of speedbrakes doubles this rate or doubles descent rate.

The design of portions of YYZ STARs sometimes makes the use of speedbrakes necessary.

**Geographic location:** Noise attenuation by geographic location is partly an extension of the square of distance rule, described above, plus attenuation due to buildings, trees, etc. In some cases, sound reflected by buildings or other hard surfaces can actually increase perceived noise. Utilizing the best of routing options keeps aircraft over the fewest people and sometimes disperses the recurring effect on a specific geographical region. There are areas where aircraft *must* be on specific tracks, such as on final approach and when flying the prescribed path of STARs. An area where geographic position is most variable in the approach segment would be on base leg where aircraft are turned in by ATC at various intervals depending on traffic conditions. The highest location of recurrence is on the downwind and final approach tracks and minimizing the noise in these areas would have a significant effect on residents.

In some cases, YYZ STARs fly aircraft over significant populated areas where other routings could be implemented to avoid this routing as well as decrease the recurring effect.
As can be seen, each factor cannot be dealt with in isolation. Early descents cause aircraft to **level off at low altitudes**, creating a need for **power**. Lower speeds create a need to **use flaps**. The extra drag flaps generate creates a need for **even more power**.

YYZ STARs create all of these conditions, almost entirely over **densely populated areas**.

A perfect storm of noise.
Response to a Letter from Nav Canada to Mr. John Carmichael, MP.

Before I begin my discussion about my proposed improvement to the STARS I would like to address a letter sent to MP Mr. John Carmichael on May 10, 2013 by Ms. Michelle Bishop, Director, Government and Public Affairs, Nav Canada, a copy of which is included as Appendix G. The letter deals with both technical issues and public notification regarding implementation of the "new" STARs.

Two technical issues were brought up by Ms. Bishop in that letter.

The first was a reference to the ICAO criteria for turning over "Fly-by-waypoints" explaining why the downwind legs of the STARS had been moved farther from the final approach course. Without getting into a long discussion about Fly-by- or Fly-over-waypoints, YYZ STARs do not have any turns from the downwind leg which reference any fly-by- or fly-over-waypoints. Turns from downwind are initiated by air traffic controllers and any turn over any waypoint is pure coincidence so inclusion of these comments was irrelevant.

With respect to her reference to ICAO criteria, It should be noted that Nav Canada has many waivers to ICAO standards on file. So compliance with ICAO recommendations, while preferable in most cases, is not absolutely mandatory.

In another part of her letter, Ms. Bishop indicates that the 4500 foot restriction at MAROD is there because a 5500 ft. restriction "would require too steep of a descent for safe operations". This is patently untrue. Any aircraft could easily descend, without the use of speedbrakes, and complete a smooth approach to RWY 24 L/R from this point at 5500 ft.; even as high as 6000 ft. A turn over MAROD at 4500 ft. and 200 kts requires aircraft to level-off for 2 miles at 3000 ft. This is borne out by viewing the Webtrak website for only a few minutes. While “clean” aircraft descend at about 300 ft. /mile, aircraft with flaps extended descend more steeply.

Ultimately, the letter only served as an apparent attempt to obfuscate. I find it odd that Nav Canada and Ms. Bishop would rather hide behind irrelevant rules and untrue information under the premise of safety or ICAO standards to defend badly designed STARs than try to implement an easy fix to the problem.
The LINNG STAR to Runways 24L/R

My discussions from hereon will concentrate on the LINNG and ROKTO STARs (Appendix E) to runway 24 L/R in YYZ, although the same principles can be applied to all of the other STARs following similar patterns.... essentially all non-straight-in approaches. In this discussion, I will refer to the "approach gate" which is the closest point to the airport that aircraft can be when they turn final above the minimum altitude and be on the glideslope. It is at 7.5 miles from the runway at 3000 ft. This is not an official term, just one used here for clarity.

The LINNG arrival crosses Lake Ontario from the southeast and the normal arrival routing for traffic from South America, the Caribbean and anywhere south and east of Chicago, including the Boston, New York, Washington area. The ROKTO arrival is from the west, passing over the Waterloo VOR. It is normally the routing for any traffic from the US originating west of Chicago including Chicago itself and Minneapolis and, depending on enroute winds, traffic from Vancouver and Calgary and the Pacific Rim.

The two STARs join at VERKO intersection, essentially over Long Branch at the south end of Browns Line on the Mississauga/Etobicoke border.

Traffic generally overflies VERKO at between 6000 and 8000 ft. at 220 kts. Traffic from the south is often at the higher altitude ranges crossing VERKO due to the current practice of having traffic on the LINNG arrival stay above departing eastbound traffic crossing under it at 7000 ft. More on that later.

At a distance 11.4 miles NE of VERKO lies MAROD intersection. Aircraft are required to cross MAROD below 4500 feet at 200 kts. In addition, when 24 L/R are in use, the wind at altitude is often 20-25 kts from the west. If an aircraft from LINNG crosses VERKO at 8000 ft. and 220 kts, using the 300 ft. per mile and 10 kts per mile calculation it can be seen that it requires 13 miles to descend to 4500 ft. So, aircraft must use speedbrakes for one mile to meet this altitude restriction, then extend flaps to meet the speed restriction. Fuel and noise. Often flaps and speedbrakes must be used together because of the low speed. Even more fuel and noise. To add insult to injury, they are too low for even the shortest distance to the approach gate, so after using speedbrakes, they must now apply power to level off for 2 miles.

What altitudes are required for a smooth, quiet approach?

Aircraft can be turned onto base leg as early as a couple miles prior to MAROD. An earlier turn would not allow them to be outside the approach gate. Even for this early turn, the lowest altitude necessary at that point to descend smoothly and roll out on final on the glideslope would be 4700 feet.
Simple arithmetic would show that flying two miles further away from the airport would actually result in flying 4 miles (2 away from the airport, then 2 back again). That means that the maximum altitude to make a safe approach to YYZ from MAROD would be 4700 + (4*300) = 5900 ft. 100 ft. can be easily dealt with by a jet aircraft, so let's round it to 6000 ft. So, according to the STAR, aircraft must descend to cross MAROD at 4500 ft., even though they could be as high as 6000 ft.

In addition, aircraft are currently required to slow to 200 kts by MAROD. This requires the use of flaps, thus more power. Flaps create noise. Flaps increase fuel burn by 1 kg per mile. The combination of the difference between clean at 6000 ft. and flap 1 at 3000 is illustrated in the Appendix A to make a total difference of 3.35 kg of fuel per mile.

When previous traffic doesn't permit a turn at MAROD, aircraft could be required to fly up to 8 miles further from the airport before turning onto base. That could mean that they might have up to 28 miles to fly to the airport from this point, or as little as 18. Pilots generally don't like to fly at 500 foot increments, and a current ATC requirement causes ATC to clear the flight down to 4000 or 3000 ft. Counterintuitive as it may seem, flights on the ROKTO STAR have to descend even lower as they travel further from the airport. Thankfully, ATC uses common sense and normally cancels the 3000 ft. restriction and keeps the traffic planned to fly farther at 4000 ft. A small victory. In fact, aircraft planned to fly some of the distances they are required to fly in heavier traffic could be as high as 9000 ft. over MAROD, but that reduces options and would not significantly reduce noise attenuation from the baseline of 6000. Half of not much is not much. 6000 ft. gives excellent reduction in perceived noise while keeping all available options open.

Under current procedures, some aircraft are level at 4000 ft. and others at 3000 ft., both with flaps out, heading away from the airport and engines burning jet fuel. (Appendix C and D) They could still be at 6000 ft. And, for the want of a change in speed of 10%, they could be operating with flaps up, reducing both noise and fuel burn significantly.

**How much noise is created by the current STARs and ATC procedures?**

Let's compare the aircraft at 3000 ft. with flaps out with an aircraft at 6000 ft. with flaps retracted. Please refer to Appendix C and D for graphics.

First, one position of flaps doubles the normal aerodynamic noise of an aircraft.

Second, because these aircraft are in level flight, power must be used. Another almost doubling of noise.

So, even if these aircraft were at 6000 ft., an aircraft with flaps extended would be almost 4 times as noisy as a clean aircraft.

But we have to compensate for noise attenuation due to distance.
First we have to adjust the altitude for ground level. In Toronto, ground level is at about 500 ft. ASL. The aircraft at 3000 ft. is really 2500 ft. AGL. The aircraft at 6000 ft. is at 5500 ft. AGL.

The magnitude in difference in noise is calculated as \((5500/2500)^2 = 4.84\). So even if the aircraft at 3000 ft. was in the same configuration as the aircraft at 6000 ft., the noise from the aircraft at 3000 ft. would be 4.84 times louder.
But we still have to multiply the effect by the configuration multiplication factors. So multiply \(4.84 \times 4 = 19.36\).

So an **aircraft at 3000 ft. with flaps out sounds 20 times (~13 db) louder than the one at 6000 ft. clean.** Yet, YYZ STAR designers built that noise right into the STARs approaching every runway at Pearson.

There is also fuel consumption to consider. The difference of being at 6000 ft. with flaps up to 3000 ft. with flaps at position 1 works out to 3.35 kg of fuel per mile (Appendix A). In the absence of actual data, casual observation of flights on the Webtrak system would lead me to believe that the average flight that goes past MAROD is level at 3000 or 4000 ft. (with flaps extended) for about 5-10 miles.

*What do other airports do?*

A survey of 15 major airports around the world including all major airports in Canada and Europe (known for their insistence on ICAO standards and noise abatement) resulted in only two others (Montreal Trudeau and Memphis) having a "BELOW" crossing restriction on the downwind leg. Essentially, most STARs where aircraft fly a downwind leg have an "At or Above" restriction abeam the airport... the equivalent of VERKO... and the controller clears the aircraft to the appropriate altitude based on current traffic and the point where he anticipates turning the traffic onto base. Examples are included as Appendix F.

Probably the most efficient descent in the "noise envelope" (below 6000 ft.) I have observed from the many airports into which I have flown around the world is London Heathrow (LHR). Their Continuous Descent Approach procedure (CDA) starts at either 7000 ft. or 8000 ft., where they advise the aircraft when it is "24 miles to the runway". The aircraft stays clean (or sometimes at flap one if ATC has asked for a slower speed) and descends with a slight amount of power on at about 800 ft. per minute. The aircraft is vectored onto final right on the glideslope gradually taking more flap and landing gear as it gets closer to the airport with very little power change. Interception of final approach, on the glideslope, is often about 4000 ft. Landing gear and final flap are normally taken at about 2000 ft., as they are at most airports.
Many other airports utilize these same concepts of continuous descents. Despite the fact that the phrase “Continuous Descent” seems to creep into various press releases and correspondence from Nav Canada, there is no semblance of CDA in YYZ STARs.

Although Nav Canada has created graphics showing the amount of time that aircraft arriving in YYZ below 6000 ft., as described above, there is simply no comparison between the sound of aircraft between 3000 ft., where many of them spend a lot of time, and 6000 ft.

After observing WebTrak for some time, it occurred to me that YYZ ATC is managing the tracks of inbound aircraft quite well, given the lateral restrictions of the current STARS. Aircraft are being turned onto base leg at reasonable points based on traffic and in-trail separation is very good. But the vertical paths are quite inconsistent and could be managed much better.

So, the two most common failings of the YYZ STARs are the fact that they force aircraft to extend flaps due to the low prescribed speeds and they force aircraft to spend a lot of time in level flight at 3000 and 4000 ft. over populated areas. Frankly, I don't see this anywhere else in the world that I have flown.

Operating with flaps retracted as long as possible and avoiding level flight below 6000 ft. would solve much of the noise impact problem around YYZ for a significant portion of the population.
Hi-Low Base Legs and TCAS (Traffic Collision Alerting System)

In terminal areas, radar separation standards are such that aircraft cannot be within 3 miles of each other unless they are separated by 1000 ft. vertically or they are established on the final approach course. The north runway at YYZ (runway 23) is 2.2 miles from the south runway (runway 24R). Since this horizontal distance is less than the 3 mile criteria, aircraft approaching their respective runways from opposite directions must be separated by 1000 ft. vertically until established on final. In addition, the minimum altitude that jet aircraft can intercept the final approach course is 3000 ft.

For a number of reasons, it was decided that traffic on the south side would intercept final approach at 3000 ft. while traffic approaching to the north runway would intercept final approach at 4000 ft. An exception can occur in YYZ if one of them has accepted a “visual approach” (only available when weather is good). Also, if there is no traffic approaching on the north side, there is obviously no requirement for the south-side aircraft to be at 3000 ft. Finally, if traffic volume is high, and flights are expected to travel further away from the airport YYZ ATC will normally “flip” this requirement so that south-side aircraft will remain at 4000 ft. So, there are many opportunities to have south-side traffic higher. I feel that there are opportunities to have it as high as 6000 ft. during busy periods where aircraft travel farther downwind. This would reduce perceived noise by more than 60%, just by moving this traffic from 4000 to 6000 ft.

Traffic Collision Alert System (TCAS) is an on-board system, independent of ATC, which displays proximate traffic to the pilot and provides coordinated fly up or down instructions in the event of an imminent collision.

[In the original version of this document, a long description of TCAS was undertaken. It has been removed here because of its relevance to the discussion.]

There are options to prevent violation of separation standards other than by having aircraft at 3000 and 4000 ft. for significant mileage. Current STARs create cockpit indications that communicate to the pilot that he is too high. Modifying the STARs and allowing controllers to specify the ideal descent point would ensure that aircraft are at much more optimal altitudes throughout the approach without giving incorrect vertical path indications to the pilots.

At the very least, if the Hi-Low concept must be maintained, the southern complex base leg altitude should be raised to 5000 ft. instead of 3000 ft. as there is absolutely no need for it to be any lower except by maybe a few hundred feet on an early turn-in (on which the Hi-Low altitude restriction is moot, anyway). This would allow most aircraft to remain at 6000 ft. over the majority of the STAR.
Recommendations for Phase 1:

The following are recommendations for the LINNG and ROKTO STARs to runway 24 L/R (with similar changes to similar STARs to other runways)
- All aircraft cross VERKO at 7000 and 220 kts
- This would be the last restriction on the STAR.
- ATC should issue descent clearance based on where they intend to turn the aircraft: The farther downwind the aircraft is expected to fly, the higher the cleared altitude.

Similar processes are common around the world. All of these options would even allow aircraft at 6000 to be turned in early if the opportunity presented itself to the controller, although this would not be as comfortable for passengers as speedbrakes would be used.

There are other options for the actual technique of issuing descent clearances, each having their own accuracy and amount of direct control.

These recommendations would reduce the noise substantially for:
- Residents on downwind, who are high-recurring recipients of noise at various altitudes. This noise can sometimes exceed the noise of an aircraft on final approach below 3000 ft.
- Residents on final approach outside 7.5 miles (subject to high drag, level flight at 3000 ft) who are even higher recurring recipients.
- Residents on base, who are occasional recipients but subject to moderate drag, level flight at medium-low altitudes.
- Residents more than 15 radius miles from the airport as aircraft would rarely be below 6000 ft. and would be in low drag configuration.

Pilots should not have to be concerned that they will be "dumped" in. All of these altitudes are easily reachable with a simple descent clearance inside VERKO. And all of them result in, essentially, continuous descents from 6000 ft. Descent clearance should be issued at the appropriate time to time optimal height at the beginning of planned the base leg. Controllers can adjust this point based on previous flight performance on interception of final approach. Once pilots are educated in this situation and experience it, they will no longer use speedbrakes to descend.

When one really thinks about it, beyond the general poor design of the STARs, how could a STAR designer 3 years ago know and anticipate all of the permutations of today’s minute to minute traffic at a major airport and create restrictions for the best altitudes to operate at? That’s why we pay our highly trained air traffic controllers.

We should let air traffic controllers do their job. Other countries do so.

Phase 2: Rerouting the STARs
It is anticipated that changing STAR *altitudes* could be attained relatively easily by issuing NOTAM, after testing and controller training, of course. No new waypoints would have to be created and many of the techniques used are currently utilized randomly by controllers anyway. It is consistent application of best practices that would reduce noise and cost the least. Nav Canada has changed STAR altitudes simply by NOTAM in the recent past.

But that is only phase one.

One area that would take more time and effort is rerouting of STARs to make them significantly more efficient.

The current routing of the STAR from LINNG is from a point named YOUTH in mid-Lake Ontario Northwesterly to VERKO, over Long Branch. Aircraft then make a right-angle turn to join the downwind towards MAROD, in the vicinity of MAROD, aircraft make a left right-angle turn to join the base leg for runway 24 left and right.

As we know, a straight line is the shortest distance between two points. The right angle journey over VERKO for aircraft arriving from YOUTH is 7 nautical miles farther than a straight line between YOUTH and MAROD. Even in many cars, this would result in the burn of 1 litre of gasoline. In an aircraft it would burn up to 100 litres. So, for every single flight from LGA, EWR, BOS, ATL, CLT, all of Florida, all of the Caribbean and South America, it costs the airlines about $100 *per flight* to make this journey and adds about 300 kg of greenhouse gases to the atmosphere. (Appendix B)

It is recommended that routing from YOUTH should go direct to MAROD.

It should be remembered that this "fix" could apply, as well, to all routings arriving from the north over FLINE (including most of western Canada flights) or south over LINNG to any of the east west oriented runways. This would save millions of litres of fuel per year.

In addition, the track from VERKO to MAROD passes over 12 nautical miles of highly populated areas of Etobicoke, Toronto and East York. Ironically, the lower the aircraft, the higher the population density. A line from YOUTH to MAROD would cross the shoreline just east of the island airport and travel roughly over the Don Valley. The actual populated area along this route nets out at about 4 nm.

Occasionally, but very rarely, ATC does vector aircraft coming from YOUTH to intercept the downwind leg between VERKO and MAROD, but not often. The reduced mileage is not normally anticipated and, because pilots work hard at managing their descents and while they do appreciate the time savings these opportunities present, very little fuel is saved because speedbrakes must be used to get the aircraft back "in the slot".... the normal descent path.

It is my recommendation that this routing become a standard.
Advantages of rerouting:

- The intersection of traffic from the ROKTO STAR is at a more obtuse angle. This gives the controller the option of vectoring the LINNG traffic left or right of the inbound course to MAROD to provide separation while still having less than a 90 degree turn onto downwind when that is required.
- The controller has many options in terms of where he would send the aircraft as it approaches MAROD. He could break off the STAR and vector the aircraft inside MAROD for a tight base, vector it straight through MAROD for a moderate base or allow it to continue the STAR downwind at 6000 ft. for a wide base.
- This "scattering" prior to MAROD would reduce the amount of noise for the most people by reducing the downwind over populated areas. It would also reduce the recurring noise for those residents living in the area of MAROD. The same principles would apply as under the scenario above, where controllers would clear aircraft to different altitudes at the appropriate distance to allow a continuous descent to the glideslope.

But, more important than that, in addition to the savings for inbound flights, moving the routing farther east would save **millions of litres of fuel per year** for departures.

Here's how:

When the 24s are in use in YYZ, traffic heading eastbound, turn east at the shoreline of Mississauga. This probably is 1/2 of all traffic as it encompasses all traffic to YUL, YOW, the east coast of Canada and the US (BOS, LGA, EWR, IAD, PHL), the outer Caribbean and Europe. Because there is crossing traffic on the LINNG arrival from YOUTH to VERKO descending to 8000, climbing eastbound traffic is levelled at 7000 feet until they are past the descent leg on the LINNG arrival. Now, most traffic could be well above 9000 by the time they get to this crossing point, but the designers felt that it was too close to feel comfortable having aircraft climb prior to the crossover.

Simulator testing has shown that departing aircraft must stay level at 7000 ft. for about 12 miles before being able to climb higher (medium distance flights would arrive at 7000 ft. earlier, so would be even longer in level flight). This means that they arrive at cruise altitude 12 miles later. The difference in fuel burn for that 12 miles between 7,000 and 35,000 feet is approximately 100 kg for a wide body aircraft... about $100(Appendix B). And, of course, it saves 1.5 minutes because, at 7000 ft. the aircraft is flying at 250 knots, while at 35000 feet it is flying at almost 500 kts. .. at airlines' costing that works out to another $75. Cost for each departure held at 7000 ft. = $175. Rough numbers of departures at about 250 /day utilizing this route would mean that, for the days that the 24s are in use (about 70% of the time), 6 million kg of fuel would be saved with a total savings, in time and fuel, of over $10 million.

By moving the inbound leg from LINNG farther east by having it go direct to MAROD, it moves the crossing point at which the departing eastbound traffic needs to be above the
inbound traffic. In addition, a point about 8 miles south of MAROD could be created at which inbound traffic must be at 7000 ft. and 220 kts (remember the reference to 7000 ft. at VERKO, above). This would also create a guaranteed minimum altitude for aircraft arriving and departing Billy Bishop Airport.

So, now, the northbound, inbound traffic is guaranteed to be lower and the outbound traffic has an extra 5 miles to continue their climb, and get above the (now lower) inbound traffic, instead of leveling at 7000 ft. As an added bonus, as aircraft pass abeam the highly populated area of downtown Toronto and its noise sensitive waterfront, they will be at 13000 ft., instead of applying climb thrust at 7000 ft., reducing noise for more people even further. In addition, vertical separation between eastbound and northbound flights would be higher, reducing controller workload as they no longer have to point out the crossing traffic 1000 ft. above or below. Any flights having difficulty climbing could be forced to remain down at 5000, or vectored slightly north over MAROD, where inbound traffic would be lower. But there would be very few, if any, of these. Aircraft departing YYZ can't even turn from the departure path until they are at 3600 feet ASL (3000 AGL), so simple math (and spinning them on a pinhead, even without the crosswind leg) would put them back over the airport above 6500 ft., even without the crosswind leg to the southeast. Climbing traffic would only have to be at 8000 ft. some 17 flying miles further.

Aircraft at 250 kts climb at about 500 feet per mile in lower levels. So, getting well above this new inbound leg would be an easy task. In fact, I feel that most aircraft could be well above even the existing inbound leg but, unless there is no traffic on the YOUTH-VERKO approach segment, they are never cleared above 7000 until past it.

So, while this phase would take more effort to change, the change to the inbound routing which also allows the eastbound departures to climb could save up to $10 million per year.

This same principle of direct routing could be used to bypass ERBUS from the north and provide similar savings to crossing, climbing traffic there.
Other issues

There are many other issues with YYZ STARs. The FLINE arrival has aircraft below 10000 ft. a minimum of 40 miles from the airport (because of the right angle at ERBUS) even if the aircraft can be turned in at the minimum base distance. This is only about 5 miles early, but as we showed earlier, the difference in fuel of 12 miles between cruise and descent adds up quickly. This is not as busy as the LINNG routing, but savings could easily be in the $3 million range if this altitude was optimized. And... of course, if the direct routing to the downwind point was utilized, savings would be millions more. Other STARs also have aircraft down much earlier than necessary. The ROKTO arrival from the west landing on 24 has aircraft at 10,000 ft. 55 miles from the airport (15 miles early) and there is no relief available by the direct routings as suggested from FLINE.

From a safety perspective, the current STARs put aircraft many miles from the airport at altitudes at which they may interact with recreational aircraft operating from Burlington, Brampton, Buttonville or Markham airports. In addition, the low potential altitude of aircraft on downwind and base, means that the TRSA must be lower, farther from the airport. This "squeezes" the altitudes that recreational flights can use, especially over the Niagara Escarpment. This effect was cited as the primary factor in the mid-air collision between two aircraft operating from Brampton airport a few years ago [TSB Final Report A06O0206-Mid-Air Collision]. Having higher altitudes may not allow the base of the TRSA to be raised, but without the change, it certainly cannot be.

Recreational aircraft below the TRSA at farther distances can be out of radar control as high as 2400 ft. in the same geographical area as 600-seat passenger aircraft at 3000 ft. operating in accordance with the current STARs. This 600 ft. separation violates all normal separation standards, might even cause a TCAS Traffic Advisory and airline pilots are not even aware that recreational pilots may be so close.
Conclusion

YYZ STARs are a major factor in residential noise in Toronto and the GTA created by aircraft. They contain procedures that require aircraft to descend too early, slow down too soon thus putting the aircraft close to the ground in high noise configurations.

A phased process to change the STARs to be more resident-friendly is recommended.

The first phase recommends that altitudes and speeds be modified to allow aircraft to remain higher and keep flaps retracted. The simple changing of altitude and speed could be implemented quickly and reduce noise by 85% for a great number of residents and save over 3 million kg of fuel per year.

As an extension of the high/clean concept, it is also recommended that flights between 2330 and 0600 should remain at 6000 ft. until the latter of base leg initiation or the point at which a low drag, low power, no speedbrake descent can be achieved. Although this may require some arrivals to fly up to 4 track miles farther, the number of flights is relatively small and the requirement is a rational trade off for the privilege of operating during the overnight hours. It would not be all flights that would have to fly farther, in any case, as there are many examples available of flights travelling downwind many miles during these hours.

The second phase recommends changes to arrival routings that would improve noise further, save miles flown, improve controller options and allow departures to climb sooner saving more fuel, resulting in annual savings of 10 million kg of fuel.

Overall, by implementing these changes, safety will be increased while fuel burn, noise and costs will decrease.
Appendix A

Aircraft performance information - Flaps Up at 6000 ft. vs Flaps 1 at 3000 ft.

The above tables are B-787-8 performance data. If we assume a common landing weight of 160,000 kg;

- at 5000 ft, flaps up at 220 kts, fuel burn is 2090 kg/hr per engine... 4180 kg/hr total... 19 kg per mile.
- at 5000 ft, flaps 1 at 195 kts, fuel burn is 2150 kg per engine ... 4300 kg/hr total... 22 kg per mile.

Interpolating the data,
- at 6000 ft, flaps up, 220 kts, fuel burn is 18.9 kg/mile
- at 3000 ft, flaps 1, at 195 kts, fuel burn is 22.25 kg/mile

So for every mile flown by this aircraft level at 3000 with flap 1 vs 6000 and clean, an additional 3.35 kg of fuel is burned.

There are about 600 landings a day in YYZ. Hundreds of aircraft spend 5-10 miles level at 3000 ft. and flaps 1 every day when all of that "level" time could have been at 6000 ft. flaps up.... Assuming 300 flights a day at 3000 ft for 8 miles, annual savings would be $2.93 million.
To illustrate the fuel and money savings offered by the proposal put forward in Phase 2, we will compare the difference at takeoff weight of spending 12 miles at 7,000 ft. vs at cruise altitude.

- At 220,000 kg, 7000 ft., flaps up, 245 kts, burn is 2780 kg/hr/engine ... 5560 kg/hr total ... 22.7 kg/mile.
- At 220,000 kg, 37,000 ft., M.847=485 kts, burn is 3055 kg/hr/engine... 6110 kg/hr total... 12.6 kg/mile.

So, every flight that has to level at 7,000 ft. for 12 miles, an extra 121 kg of fuel is burned. In addition, it would save 1.5 minutes, which airlines price out at $50 per minute.
We know that the westbound runway arrangement is used more than \( \frac{1}{2} \) the time and that more than \( \frac{1}{2} \) of departures go eastbound. So, at least \( \frac{1}{4} \) of departures would benefit… 150 per day on average… over $6 million dollars per year.

The 7 miles saved on the proposed inbound tracks from YOUTH, would save 70 kg per flight, even on an A320…. almost $4 million per year for just 150 flights per day, plus time savings of almost 2 minutes per arrival on this transition. Similar time and fuel savings occur in each of the other quadrants.
Appendix C
Current and proposed traffic altitude and noise patterns

Figure 1

In Figure 1 and 2, the altitude of aircraft in the two scenarios is shown as solid shading with the predicted sound levels indicated by the numeric overlays. A table is provided on each graphic to show the calculation for various aircraft altitudes, configurations and modes (descent or level flight).

The baseline sound level of 1 is based on flaps up, level flight at 6000 ft. The indicated sound levels are perceived sound multiples of this baseline, not decibel differences.

Figure 1 shows the current range of noise levels in the LINNG STAR vectoring area. The “At or above” altitude restriction at DEKNI applies on the LINNG STAR, but the ROKTO STAR following the same path has this point as “At 3000”

As can be seen there are large areas where sound levels exceed 5, or even 10, times the baseline level and areas near the “approach gate” of 3000 ft. and 7.5 miles where it can be in excess of 15 times the baseline.

Figure 2
Figure 2 shows the proposed altitudes and predicted sound levels using the proposed altitudes. As can be seen, the area where sound levels exceed the 5 times baseline only occur very close to the approach gate and occur only where the current procedure results in sound levels of 10 to 15 times baseline.

One thing that cannot be shown in these graphics is frequency of flight. The area on the downwind leg and on final approach are the two most frequently overflown tracks with the areas on these tracks closest to MAROD and the approach gate being the most frequently overflown ground points.

Areas between the downwind and final approach tracks get overflown at random based on when the air traffic controller turns the aircraft onto base leg, so recurrence of noise in these areas is less.

Most of the noise compliance criteria in YYZ is based solely on turning final at or above 3000 ft. An aircraft on descent at 2500 ft. actually makes less noise than an aircraft in the same configuration, level at 3000 ft., making areas like Leaside more noisy than “noise impacted” areas within 8 miles of the airport.
Appendix D

Graphic 3-Dimensional representation of current flight paths and noise levels

Figure 3 gives a three-dimensional perspective to the flight paths and noise footprints around YYZ.

In this graphic, three base leg flight path scenarios are shown, but there are many more that would occur between these paths as this is controlled on an individual flight basis by the air traffic controller based on current traffic.

The vertical perspective shows the current flight path in red (sometimes rendered in black), while the higher, proposed flight path is shown in green.

The “towers” give a view of the relative amount of noise that is predicted based on altitude, configuration and mode of flight at each of the points. The green “base” of the towers show the expected noise levels under the proposed change while the in-every-case much taller yellow/red towers show the noise levels in the current STAR implementation.

The effect of flap extension on noise can be seen on mid-base leg in the two closer in base leg scenarios. In the wider base scenario under the proposed changes, flap selection doesn’t occur until the aircraft is on base and ready to descend from 6000 ft. Currently, flap is selected approaching MAROD and aircraft fly at 3000 or 4000 ft. on base leg.
Figures 4 and 5 provide different perspectives of the current and proposed changes without the noise towers. These perspectives show the dramatic difference in height that will be achieved with the proposed changes.
Figure 6 shows the current and proposed noise footprint over the Milton/Halton Hills area to Runway 05.
Traffic on the final approach course at 3000 ft. is up to 8 times louder than it needs to be and over the most heavily populated areas of Milton, noise is more than 6 times greater than necessary. In fact, the final approach course to runways 06 L and R also flies, at a low altitude in high noise configuration over the new subdivisions in South Milton.
In many areas of the affected areas around Pearson, noise is greater than on final approach over Mississauga where neighbourhoods have “Aircraft Noise Warning” signs.

Figure 7
Appendix E
Jeppesen charts for YYZ STARs

Figures 8 and 9 show the STARs that pass over the primary area being discussed in this paper: the approach to runway 24 L/R. Figure 10 shows the LINNG arrival to runway 06 L/R so that the reader has the opportunity to see the same processes currently in place and how similar changes would improve noise impacts in that quadrant (and, in fact, the north quadrants as well). All charts are copyright Jeppesen Inc.

Figure 8
It is interesting to note, that the ROKTO STAR has a specific altitude at DEKNI, while the LINNG STAR has an “At or Above” restriction at the exact same point, even though Nav Canada insists that a specific altitude is required at the end of the downwind leg.
Figure 10
Appendix F

Examples of STARs from around the world without “At or Below” restrictions

Other airports surveyed and did not have “At or Below” or specific altitude restrictions on the downwind leg (charts not included for brevity) were Minneapolis, London, Dallas, Atlanta, Miami, Singapore, Beijing, Vancouver, Calgary, Madrid and Seattle. The only airports found with these restrictions were Montreal Trudeau and Memphis. It is the author’s understanding that new STARs for Winnipeg now also include this type of restriction, despite the objections of airlines. All charts are copyright Jeppesen Inc.
Appendix G
Letter from Nav Canada to John Carmichael, M.P.

May 10, 2013

Mr. John Carmichael, M.P.
(Don Valley West)
House of Commons
Ottawa ON
K1A 0A6

RE: Standard Terminal Arrival Route changes at CYYZ

Mr. Carmichael,

Thank you for your letter of March 8, 2013 further to my letter of January 17. I am pleased to address below your ongoing questions regarding the changes that were made to arrival flight paths in the area of Don Valley West.

Reason why the flight path was shifted 1.8 kms

As I explained in my earlier letter and in the meeting in your constituency office in October 2012, the downwind portion of the arrival path was relocated in order to meet International Civil Aviation Organization (ICAO) current design standards.

I have appended for your information (see Appendix A) tables relating to the design standards that are used by approach designers in determining minimum segment length for arrivals. These charts are incorporated in TP308 Criteria for the Development of Instrument Procedures, issued by Transport Canada.

Canadian Aviation Regulations (CARs), published under the authority of The Aeronautics Act, read as follows:

803.02 No person shall publish or submit for publishing in the Canada Air Pilot an instrument procedure unless the procedure has been developed
(a) in accordance with the standards and criteria specified in the manual entitled *Criteria for the Development of Instrument Procedures*; and

(b) by a person who has successfully completed training in the interpretation and application of the standards and criteria specified in the manual entitled *Criteria for the Development of Instrument Procedures*, which training has been accepted by the Minister.

While these are technical documents, intended for use by certified instrument approach designers, calculations based on these tables determine that the minimum segment length required for a fly-by-waypoint arrival for a flight path that includes two 90 degree turns in the same direction (the initial turn from downwind to the base leg, followed by the turn from base leg to final approach) at a speed of 200 kts is deemed to be 5.2 NM.

Prior to February 2012, the base leg segment of the approach was 4.2 NM. It was the need to lengthen that segment to a minimum of 5.2 NM which required the downwind to be moved 1 NM (or 1.8 kms). The segment lengths for the arrivals approaching from north-west of the airport already met the requirements.

**Consultation and notification process and role of stakeholders**

Like any company, NAV CANADA’s mission relates to its core function -- in our instance the provision of safe, efficient and cost effective air navigation services. It is an important public trust that we take very seriously. That does not imply however that we do not have other responsibilities as well.

Like all air navigation service providers, we are conscious of the noise impact of aircraft operations on surrounding communities and work with airports, airlines and other stakeholders to reduce that impact where possible. We participate in airport noise management committees, often as a technical expert, and ensure that the flight paths we design respect noise abatement procedures and meet all applicable regulations.

While we are not required to provide notification of flight path changes to anyone but the pilots to fly them, NAV CANADA did take steps in the summer and fall of 2011 to advise the public through various means as follows:

- **Briefings on the airspace changes** were given to the Toronto–Pearson International Airport’s Community Environment and Noise Advisory Committee (CENAC) at various points during the airspace study, dating back to February 2009. CENAC was briefed specifically on the final design changes on June 1, 2011 and again on February 1, 2012, just prior to their implementation.

- CENAC is comprised of elected representatives and residents from the cities of Brampton, Mississauga and Toronto. The committee’s role includes representing their respective constituents on noise related matters dealing with the airport and disseminating the results of committee discussions to their constituent bodies. All
meetings of CENAC are open to the public to attend and include time on the agenda for the public to directly ask questions.

- There were no letters informing elected officials of flight path changes. Meetings were held that had been arranged by email and phone call. I could not however find any record that your office was contacted during this period. I sincerely apologise for the oversight and assure you that it was not intentional. Over 70 meetings were held between August and October 2011 in Montreal, Ottawa and Toronto. My records show that our first contact with your office regarding the airspace changes was in May 2012.

- In August and September 2011, NAV CANADA placed public notices in newspapers in areas where flight path changes would occur (note these included areas in Ottawa and Montreal as well as the Greater Toronto Area). I have appended a listing of the papers in which Notices appeared and the weeks in which they appeared (see Appendix B). The Notices indicated that flight paths were being amended and provided a website where the public could learn more and provide comments directly to NAV CANADA on the proposed changes. Over 7,000 people visited this portion of the website during the period prior to implementation in February 2012 where they could view maps of the old and new flight paths, graphics of flight tracks as flown by aircraft, frequently asked questions and answers and a public comment tool. The GTAA and others provided information on their websites regarding the airspace changes with a link to our website.

- I would also note that the fall of 2011 some news outlets wrote stories on the proposed flight path changes which provided additional opportunity for the public to become aware that changes would occur. I have appended some of those stories at Appendix C.

As you can see, we certainly were not concealing the fact that an airspace change was pending. And as I indicated in my January letter, NAV CANADA must ensure that flight paths meet international design standards. Consultation input would not have materially altered this fact.

However, we appreciate the feedback from residents who were not aware of the change until after it was in place. We will work with airports and various levels of government to provide better communication in the future.

**Rotation of flight paths**

My January 17 letter primarily dealt with residents questions, expressed at the October 2012 meeting, regarding whether the downwind portion of the flight path could be relocated either over the lake, or south of its current location.

"Rotating" or varying flight paths over a wider area of the GTA, ostensibly to spread the noise impact of aviation activity over a variety of communities, would add a significant amount of complexity to the current operation. At a busy airport like Toronto-Pearson, adding complexity has material safety impacts.
NAV CANADA does not rotate instrument approach procedures at any airport in Canada and would not consider doing so at Toronto Pearson.

Noise exposure from aviation activity affects a number of communities across the Greater Toronto Area, particularly when one considers the impact from operations at other area airports such as Buttonville, and Billy Bishop. As you can appreciate, there are many communities more affected than Leaside for which mitigations simply are not possible.

**Altitude of operations over Leaside**

Standard Terminal Arrivals Routes (STARs) include altitude restrictions in the design that have been set to ensure that aircraft in descent do not get too low, too early in the procedure and that the flight path ideally represents as close as possible to a constant descent angle, usually of 333 feet per nautical mile. A waypoint on the runway 24 arrival path, which is located approximately above the intersection of Eglington and Bayview, has a published altitude restriction of between 4500 and 3100 ft ASL.

The altitude restriction on the STAR does not represent a "cap" or "floor" however and air traffic controllers are able to clear aircraft to lower altitudes for safety reasons or during emergency situations if required. Those clearances must respect minimum vectoring altitudes to ensure safe separation between aircraft operations and obstacles, such as buildings. In this area, the minimum vectoring altitude would be 3000 ft ASL with the controlling obstacle being at 1787 ft. I would also add that Toronto-Pearson Airport's noise abatement procedures require that arriving aircraft maintain 3000 ft ASL prior to lining up with the runway for final approach.

While we have received some complaints about aircraft perceived as too low, often this is a perception issue due to the varying size of aircraft on the approach (i.e. an A380 looks lower than a CRJ-900, even when operating at the same altitude). In examining the flights referenced in these complaints we have not found any aircraft to be non-compliant with the published instrument approach or the airport's noise abatement procedures.

There are no operational reasons why an aircraft would want to be lower than the published approach. The approach has been designed to enable pilots to intercept the Instrument Landing System glide path on final approach at an appropriate altitude. Raising the altitude at this point in the approach to 5,500 ft ASL, as was suggested, would require too steep of a descent for safe operations, or alternatively, would require aircraft to extend the downwind leg much further from the airport, before turning back to intercept the glide path. This would have the effect of requiring the aircraft to burn more fuel and fly over many more homes en route.

The reference in your letter to an incident at La Guardia was one in which it is my understanding that the aircraft descended below the minimum vectoring altitude and the air traffic controller intervened to advise the pilot to climb. Due to their potential safety impact, such events are a reportable occurrence in Canada and are reported to Transport Canada daily in the Canadian Aviation Daily Occurrence Reports (CADORS).
Night operations

Noise abatement procedures at the airport already establish preferential runway assignment between midnight and 6:30 local time as follows:

Arrival priority: 1. Runway 05  2. Runway 15L  3. Runway 06L

On the majority of evenings, this runway assignment keeps noise north and west of the airport. Only on evenings when the winds or construction activities at the airport require arrivals on runways 23/24 for safety reasons would Leaside experience overflight from arrival operations.

It is not NAV CANADA’s intention to introduce a separate night time STAR that would avoid Leaside.

I know that these answers will not reduce the aircraft operations that are of concern to your constituents, but I do hope they will provide further clarification to any outstanding questions.

Sincerely,

Michelle Bishop
Director, Government and Public Affairs

c.c.  Toby Lennox, GTAA
Appendix H
Lexicon

Base (leg) - The arrival segment perpendicular and immediately preceding the Final Approach Course.

Crosswind (leg) - The departure segment perpendicular to, and following, the departure direction.

Downwind (leg) - the arrival segment parallel and opposite to the direction of landing. It is normally offset 5 nautical miles from the Final Approach Course.

Final (Approach Course) - The arrival segment aligned with the landing runway.

Flap - A wing device that extends from the back of the wing that allows aircraft to operate at slower speeds used for takeoff and landing. Flaps also provide drag for stability on approach. They are retracted when above a certain speed for efficiency.

Glideslope - an electronic descent path followed by aircraft for a continuous descent to the runway. It aligns with the Final Approach Course. Aircraft normally intercept the glideslope at or above 3000 ft.

SID - Standard Instrument Departure. A prescribed set of paths and altitudes pilots are required to fly on departure. They reduce pilot and controller workload by reducing communication and allowing pilots to know, in advance, what their route and altitudes will be around the airport. They also have the advantage of safety as these paths are tested in conjunction with other routes around the airport for traffic separation.

Speedbrake - A flat surface that extends from the top of the wing to increase drag and reduce lift. These allow aircraft to descend more quickly or slow down more quickly, or both.

STAR - Standard Terminal Arrival Route. This is a prescribed set of paths and altitudes pilots are required to fly when transitioning from enroute to the final approach course. They reduce pilot and controller workload by reducing communication and allowing pilots to know, in advance, what their route and altitudes will be around the airport. They also have the advantage of safety as these paths are tested in conjunction with other routes around the airport for traffic separation.

TCAS - Traffic Collision Alert System - An on-board system, independent of ATC, which displays proximate traffic to the pilot and provides coordinated fly up or down instructions in the event of an imminent collision.

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