Exhibit C

REPORT N^O 70022994-001

KINGSTON AIRPORT: AIR QUALITY EMISSIONS ASSESSMENT AND FORECAST

JUNE 6, 2016

WSP | PARSONS BRINCKERHOFF

KINGSTON AIRPORT: AIR QUALITY EMISSIONS ASSESSMENT AND FORECAST

The City of Kingston

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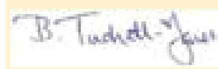
Signature				
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1 EXECUTIVE SUMMARY

The City of Kingston retained WSP | Parsons Brinckerhoff to develop an air emissions inventory for Kingston Airport, reflective of 2015 operating conditions and 2026 forecast operating conditions. By 2026, it is anticipated that the number of movements at the Airport will have increased from current levels, Runway 01/19 will have been extended by 1000ft and the terminal building expanded to accommodate the extra air traffic.

The sources included in the inventory were categorized as follows:

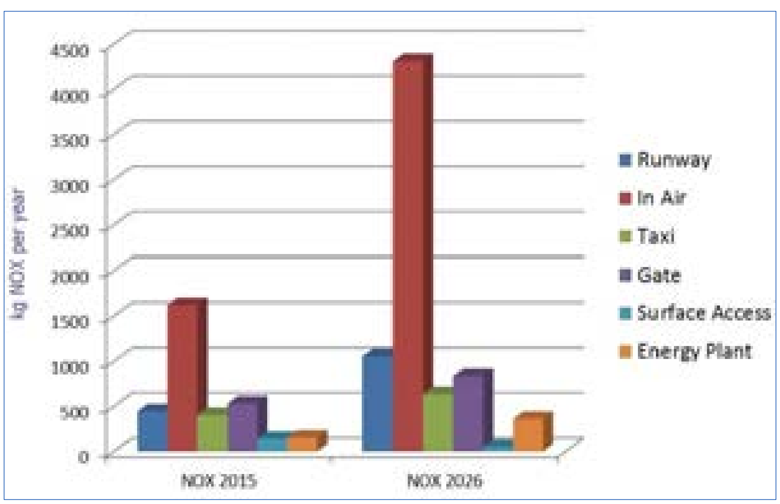
- Aircraft
- Ground Support Equipment
- Airside vehicles and plant
- Offsite traffic
- Stationary sources, including gas fired heating

Emissions of nitrogen oxides (NO_X) and particulate matter as PM_{10} were included in the study.

Total emissions from Kingston Airport in 2015 and 2026 are shown below:

YEAR	Nitrogen Oxides (kg/yr)	Particulate Matter (kg/yr)
2015	3284.1	99.7
2026	7237.1	199.6
Change 2026-2015	3953.0	99.9

A source breakdown of emissions for NO_X is shown below



where

- Runway emissions are emissions from the start of the take off roll to the point at which the aircraft reaches 50ft plus the emissions on approach from the point at which the aircraft passes 50ft to the end of the landing roll
- In air emissions are emissions between 50ft and 1000ft on landing and take-off
- Taxi emissions are emissions from aircraft engines while taxi-ing to and from the gate
- Gate emissions relate to emissions from ground support equipment and airside vehicles
- Surface access emissions are landside vehicle emissions out to a distance of 1km from the airport
- Energy plant emissions are emissions from the combustion of gas for space heating

Emissions of NO_X are dominated by emissions from aircraft engines, which comprise 56% of total emissions in 2015 and 64% in 2026, and aircraft emissions are themselves dominated by emissions whilst in the air.

Emissions from road transport decrease between 2015 and 2026 as vehicle technology improves. This partially offsets the increases resulting from increased air traffic in 2026 and gas combustion for heating.

Emissions of particulate matter are significantly lower than emissions of NO_X.

At the provincial scale the increases in emissions resulting from increased activity at the Airport are small and are equivalent to removing around 3400 passenger cars from the local road network.

Existing air quality in Kingston is very good, and the increase in exposure to air pollution in the vicinity of the airport with the increased activity in 2026 will be imperceptible.

2 INTRODUCTION

2.1 BACKGROUND

2.1.1 In 2012 a comprehensive Business Plan was prepared and adopted by the City of Kingston which included an air traffic forecast to 2026 and a runway extension to 6,000 ft for Runway 01-19. Following the completion of the Business Plan, a technical project definition study was commissioned and completed in 2013 that further analyzed the costs and technical feasibility of the necessary infrastructure improvements as recommended in the Business Plan.

2.1.2 In 2015 a screening level environmental assessment was commissioned by the City of Kingston as a matter of due diligence given the significance of the airport expansion project. Two key activities are anticipated between today and 2026 which include the extension of Runway 01-19 by 1000 ft and the expansion of the terminal building in order to accommodate larger regional type aircraft.

2.1.3 This assessment seeks to establish an air quality emissions baseline, based on 2015 aircraft movement data and international best practice inventory methods and emissions factors. As well, future emissions will be established for the 2026 timeframe based on air traffic forecasts used for the Kingston Airport Noise Exposure Forecast Report. This report then put these emissions into a context that is meaningful to the layman.

2.2 SOURCES CONSIDERED

2.2.1 Emissions to air from

- Aircraft landing and take-off cycles
- Ground Support Equipment (GSE) and airside vehicles
- Landside Vehicles and Parking Lots
- Stationary Sources (Heating Plant)

2.2.2 Other sources including auxiliary power units were scoped out of the assessment based on the likely limited scale.

2.3 POLLUTANTS CONSIDERED

2.3.1 The scope of the assessment has been limited to Nitrogen Oxides (NO_X) and Particulate Matter as PM_{10}. Taking into consideration health and ecological effects, consideration of these pollutants is sufficient to demonstrate the limited scale of impact of Kingston Airport on local air quality.

2.3.2 Nitrogen oxides are formed during fuel combustion, partly from nitrogen compounds in the fuel, but mostly by direct combination of atmospheric oxygen and nitrogen.

2.3.3 Particulate matter is the generic term for solid and liquid particles in air. It can have variable composition and a variety of sources at the airport including combustion of liquid fuels and abrasion during tire and brake wear. PM_{10} is the fraction of particulate matter that is smaller than 10microns (0.000001m) in size and inhalable.

2.4 ASSESSMENT SCOPE

2.4.1 The scope of the assessment was to produce an inventory of emissions to air from the Airport, for current operations (based on 2015 operations) and future operations (based on projected activity in 2026).

3 EMISSIONS INVENTORY

3.1 OVERVIEW

3.1.1 Emissions have been compiled using an emissions factors approach under which emissions are calculated on the basis of published factors and activity rates.

3.1.2 Basic activity data, comprising aircraft and vehicle movements, and details of ground support equipment were provided by WSP|Parsons Brinckerhoff engineers and Kingston Airport.

3.1.3 A description of the approach used to compile the inventory is provided below, with further details of the aircraft input data provided in Appendix A.

3.2 EMISSIONS INVENTORY METHODOLOGY

AIRCRAFT OPERATIONS

3.2.1 The current (2015) and projected (2026) aircraft movements at the Airport are shown in Table 3-1. A breakdown of the movements as a function of runway is shown in Appendix A, Tables A.1 and A.2.

3.2.2 The aircraft specified in the table are taken to be representative of emissions from groups of aircraft with similar performance. This approach is consistent with that taken for the noise modelling of the Airport.

Table 3-1 Representative aircraft types and movements for 2015 and 2026.

NAME	ID	TYPE	ENGINE	NO OF ENGINES	PAS	MOVEMENTS / AVERAGE DAY 2015	MOVEMENTS / AVERAGE DAY 2026
Dash 8-300	DHC830	TP	PW123	2	50	1.36	10.21
Beech 1900D	BEC190	TP	PT6A-67D	2	19	14.60	9.23
Conquest II	CNA441	TP	TPE331-8	2	8	3.20	3.24
Baron 58P	BEC58P	TP	TSI0-520-L	2	5	3.44	2.05
Cessna 172R	CNA172	P	Lycoming IO-360-L2A	1	3	51.93	82.35
C-130H	C130	TP	T56-A-15	4	92	0.14	0.27
CL601	CL601	Jet	CF34-3A	2	50	1.92	0.65
Total						**76.7**	**108.0**

TP = Turboprop; P = Piston

3.2.3 The emissions inventory sets out the total emissions of pollutants for a year. In terms of aircraft movements, it is, therefore, compiled with reference to the average number of movements per day rather than the peak movements. The 2007 Master Plan established a 2.05 relationship between the average day and the peak planning day. (If you multiply the 2026 average day by 2.05 you will get the 222 peak planning day that was used in the 2013 noise modelling.)

3.2.4 For inventory purposes, each landing and take-off (LTO) cycle was considered in six stages as shown in Table 3-2.

Table 3-2 Aircraft LTO stages

STAGE	DESCRIPTION	THRUST SETTING	COMMENT
Approach	Glide from 1000ft to touchdown	30%	Approach speed estimated at 1.3 x stall speed; constant speed
Landing Roll	Touchdown to taxi speed	30%	Landing roll from aircraft manufacturers data; constant deceleration
Taxi-In	Touchdown to gate	7%	Taxi distance calculated from end of roll to gate (aircraft dependent)
Taxi out	Gate to start of take-off roll	7%	Taxi distance estimated from gate to likely start of take-off roll (aircraft dependent)
Take-off	Take-off roll to 50ft off ground	100%	Take-off roll distance from aircraft manufacturers data; constant acceleration
Climb out	Ascent from 50ft to 1000ft	85%	Take off speed estimated as 1.2 x stall speed; no acceleration

3.2.5 Emissions are calculated as:

$$E_{ij} = \sum (TIM_{jk} \times FF_{jk} \times EI_{jk} \times NE_j)$$

Where

E_{ij} = Emissions of pollutant i in grammes, produced by aircraft type j per LTO cycle

TIM_{jk} = Time-in-mode for mode k (approach, taxi, etc) for aircraft type j, in seconds

FF_{jk} = Fuel flow for model k in kg/s for each engine on aircraft type j

EI_{jk} = Emissions index for each pollutant i in g/kg of fuel burned, in model k, for each engine used on aircraft type j, and

NE_j = Number of engines on aircraft type j

3.2.6 Emissions from International Civil Aviation Organization (ICAO) regulated engines (primarily jet engines) were taken from the ICAO databank[1]. Emissions from non-ICAO regulated engines (the majority of the Kingston fleet) were taken from the FOI (FOrskningsInstitut, Swedish Defence Research Agency) database[2] (as included in the EDMS/AEDT model[3]).

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[1] http://www.icao.int/environmental-protection/Pages/aircraft-engine-emissions.aspx, accessed 23rd May 2016

[2] http://www.foi.se/en/Our-Knowledge/Aeronautics/FOIs-Confidential-database-for-Turboprop-Engine-Emissions/, accessed 23rd May 2016

[3] EDMS = Emissions and Dispersion Modelling System; AEDT = Aviation Environmental Design Tool. https://aedt.faa.gov/

3.2.7 Both the ICAO and FOI databases provide emissions for a defined scale of LTO thrust settings, with emissions provided for take-off (100% thrust), climb-out (85%), approach (30%), idle/taxi (7%). These thrust settings were used directly in the inventory generation. In reality, aircraft rarely take off at 100% thrust and, as a result, the emissions calculated for aircraft engines are conservative in the context of the inventory i.e. tending to overestimate likely emissions.

3.2.8 Emissions within the databases are based on measurements on new engines. All emissions have been increased by a factor of 4.5%[4] to account for deterioration in engine performance over time. No change in emissions per engine is assumed between 2015 and 2026.

3.2.9 Times in Mode for each stage were calculated on the basis of the following speeds and accelerations

→ Taxi-In and Taxi-Out	5m/s	Estimated from data from UK Airports[5]
→ Take-off speed	1.2 x stall speed	Minimum likely take-off speed[6]
→ Take-off roll	Uniform acceleration from stationary to take-off speed	
→ Landing speed	1.3 x stall speed	Minimum likely landing speed[6]
→ Landing roll	Uniform deceleration to stationary from landing speed	

3.2.10 The times in mode used to generate the inventory are provided in Appendix A, Table A.3.

3.2.11 For each aircraft, the stall speed was taken from manufacturers' technical data and online pilot's manuals, together with information on the length of the landing and take-off rolls. Given the conservative assumption on engine thrust, no adjustment was made for the increase in the take off and landing distances with height above sea level (manufacturer's data is published for sea level; Kingston Airport is at 300ft asl).

3.2.12 In 2026, taxi times were increased to take account of the extension to the runway.

3.2.13 For the turbo-prop aircraft, the calculated Times in Mode were compared to the times recommended in the FOI database for emissions calculations. Where the calculated time was shorter than the FOI recommended time, the Time in Mode was adjusted to the FOI recommendation.

3.2.14 Emissions from idling of engines at the gate during start up / shut down were included, with all aircraft assumed to spend 15 minutes per landing and take off cycle in this mode. Emissions during start up were assumed to be at 7% load.

3.2.15 The ICAO and FOI databases do not provide information on emissions of particulate matter in engine exhausts. The FOI database does not include any particulate matter data at all, whereas the ICAO contains an incomplete record of smoke number. Numerous methods are available to calculate emissions, but input data availability is problematic in all cases. As a result, this assessment has taken a simplistic approach in which PM_{10} emissions from engines are assumed to be proportional to NO_X emissions. Examination of data for high thrust settings in the EDMS model showed that PM_{10} emission factors are, in general, less than 2.5% of NO_X emissions and, therefore, this has been used as the ratio of PM_{10} to NO_X emissions in the inventory for aircraft

[4] Based on recommendations from www.heathrow.com, Project for the Sustainable Development of Heathrow
[5] Relevant to all airports
[6] https://www.dept.aoe.vt.edu/, Department of Aerospace and Ocean Engineering, Virginia Tech, AOE 3104 Aircraft Performance, accessed 18th May 2016

exhaust emissions. Emissions as a function of engine model are shown in Appendix A, Table A.4.

3.2.16 PM_{10} emissions from brake and tire wear on landing are included in the inventory. Using an equation developed for Heathrow Airport in the UK[7], PM emissions from brake wear assume an emission factor of 2.51 x 10^{-7} kg PM per kg MTOW[8].

3.2.17 For tire wear, the following relationship was used:

$$PM\ (kg)\ per\ landing = 2.23\ \times\ 10^{-6} \times MTOW - 0.0874$$

3.2.18 This equation is not applicable to small aircraft (<55,000kg), and it has been assumed that PM emissions from tire wear follow a linear relationship between MTOW and PM, from the equation value at 55,000kg MTOW, intersecting at zero. Finally 10% of total PM emissions from abrasion are presumed to be in the PM_{10} size fraction. This is likely to be a conservative assumption for the aircraft types using Kingston Airport.

3.2.19 No additional deterioration in engine performance, beyond the assumed 4.5% in 2015, was assumed between 2015 and 2026.

3.2.20 All assumed aircraft movements and parameters are provided in Appendix A.

GROUND SUPPORT EQUIPMENT

3.2.21 Airside plant and ground support equipment (GSE) were assumed to meet Canadian TIER 3 emission limits for NO_X and PM_{10}, which vary from 4 – 7.5 g/kWh for NO_X and 0.2 to 0.8 g/kWh for PM_{10}, depending on the power of the engine.

3.2.22 Kingston Airport provided details of their GSE (Table 3-3). Times in mode for each GSE were estimated on the basis of observations (excluding heater and de-icing trucks) made at a small regional Airport in the UK[9].

Table 3-3 Ground Support Equipment (2015) and estimated Times in Mode (per LTO)

TYPE	POWER (KW)	TIME IN MODE (PER LTO)		
		Medium Aircraft	Small Aircraft	Very Small Aircraft
Fuel Truck	221	10	5	5
Towing Truck	235	10	5	-
Baggage Truck	235	15	10	-
Heater/AC Unit	70	20	10	-
De-Icing Truck	48	20	10	-

3.2.23 Certain aircraft using Kingston Airport have Auxiliary Power Units. Details of these were unavailable, and such emissions have been neglected. This is not a significant limitation on the

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[7] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/440316/airports-commission-final-report.pdf, and supporting studies, Airports Commission, 2015
[8] Maximum take off weight
[9] Air quality assessment for London Ashford Airport, 2012, Parsons Brinckerhoff

study. In partial compensation, all aircraft are assumed to take 15 minutes per landing and take off cycle for start up and shut down, with engines on idle.

3.2.24 Kingston Airport provided operating hours and power ratings for the various equipment used on the Airport for 2015 (Table 3-4). For 2026, the data were scaled in proportion to the increase in flight movements. This approach is likely to be conservative, since the operating times of some plant (e.g. mower) will be independent of aircraft movements. During hours of operation, plant is assumed to operate at 10% load.

Table 3-4 Airside vehicles and plant (2015)

MAKE	TYPE	CAPACITY (LTR)	KM/YEAR	POWER (KW)	HOURS / YR
FORD F-150	Pick Up	5.4	4708		
SILVERADO	Pick Up	4.8	8108		
CASE 621B	Wheel Loader			93	231
RPM LM-220	Snow Blower			151	95
JOHN DEERE 6310	Tractor			59	239
JOHN DEERE 6110	Tractor			48	540
JOHN DEERE 1565	Mower			1	197
NAVISTAR	Truck			202	259
SWEEPSTER 2900	Runway Sweeper			239	118
WORKSTAR 7600	Truck			272	142

SURFACE TRANSPORT

3.2.25 Annual emissions from roads (landside) in the vicinity of the Airport were estimated for the inventory. The data provided by the Airport consisted of average daily traffic volumes on the road approaching the Airport (Front Road, near Smugglers Cove Drive).

3.2.26 A week's survey at the start of October 2014 (01 – 07 October 2014) showed an ADT (Average Daily Traffic) of 1590 (two way), with 2% trucks and 98% cars, travelling at an average speed of 60kph.

3.2.27 It is not possible to ascertain with any certainty the proportion of traffic on this road that is directly associated with the Airport. There are residential properties on the route and it is also used to access The Landings Golf Course and Lemoine Point Conservation Area. Indeed, data provided by the Airport on use of the car park (~180 veh/day, which would give rise to 360 veh/day as a two way flow on Front Road) suggests that the proportion is relatively low (<30%).

3.2.28 Notwithstanding this, and given the uncertainty, all traffic on Front Road was included in the inventory for the Airport. For consistency with the distance from the Airport from which aircraft emissions are included (1000ft vertically, ~1km horizontally), traffic emissions are included in the inventory to a distance of 1km from the Airport.

3.2.29 Emission estimates for NO_X and PM_{10} were based on emission factors from the MOVES2014a[10] programme. In the absence of specific fleet emissions for Kingston, default parameters for the fleet composition (age/technology/fuel) were used to derive year-specific emission factors for the pollutants of interest (Table 3-5). The effects of improvements in vehicle technology over time can be seen in the emissions factors for 2015 and 2026.

Table 3-5 Vehicle emission factors (from MOVES2014a)

YEAR	VEHICLE	NO_X G/KM	PM10 G/KM
2015	Cars	0.235	0.029
	Trucks (Light)	0.427	0.036
2026	Cars	0.058	0.022
	Trucks (Light)	0.099	0.030

3.2.30 For the purpose of this inventory (in which all traffic is assumed to be Airport-related), traffic in 2026 was assumed to have grown in relation to 2015 data in proportion to the growth in aircraft movements (~11%).

ENERGY PLANT

3.2.31 There are a number of buildings on the Airport that use natural gas heating systems. These are set out in Table 3-6. By 2026, it is assumed that the Airport terminal building will be expanded by 375m^2 and that Hangars 4 (currently heated by electricity) and 5 will be replaced (approximate 80m by 50m footprint each) and heated with gas.

Table 3-6 Airport building details (gas heated buildings only)

BUILDING	FOOTPRINT 2015 (M^3)	FOOTPRINT 2026 (M^2)	BENCHMARK HEATING VALUE (KWH/M2)
Central Airway Corp.	1346	1346	264
Air Terminal Building	1360	1735	294
Hangar 5 – Kingston Flying Club	650	replaced	256
Airport Maintenance	510	510	264
R.C.A.F.A. Club	584	584	294
A.O.G.	696	696	294
The Landings Club House	186	186	294
New Hangars (2026)		2 x 4000	256

3.2.32 Emissions from the combustion of gas were estimated using factors from the US EPA AP42 database[11], coupled with a benchmark heating value for each building type (kWh/m^2).

3.2.33 An emission factor of 50lb NO_X/scf[12] was selected from AP42 as representative of small scale combustion in low NO_X burners. The benchmark heating values were taken from CIBSE Energy

[10] https://www3.epa.gov/otaq/models/moves/index.htm, accessed 16th May 2016
[11] https://www3.epa.gov/ttnchie1/ap42/ch01/bgdocs/b01s04.pdf, AP42 Section 1.4 Natural Gas Combustion, accessed 25th May 2016

Benchmarks[13], with an adjustment for degree days based on average monthly temperatures in Kingston[14]. Building types were taken variously to be Airport terminals, workshops and storage areas. The heating systems were assumed to be 80% efficient. This is a conservative assumption.

3.2.34 The estimated heating value for the Airport terminal building and maintenance areas correlated well with the limited gas consumption data available.

3.2.35 Emissions of particulate matter from the combustion of natural gas are negligible.

3.3 KEY ASSUMPTIONS AND LIMITATIONS

3.3.1 The key assumption in generating the emissions inventory is the number of aircraft movements. This is well constrained for 2015 but is subject to some uncertainty in 2026. The growth in movements and emissions between 2015 and 2026 is largely related to increased passenger flights.

3.3.2 Particulate matter emissions are subject to greater uncertainty than emissions of nitrogen dioxide, primarily due to the absence of engine emissions data. However, the magnitude of the emissions is small and PM_{10} emissions are unlikely to place a constraint on the operations of the Airport.

3.3.3 Times in mode for various stages of the LTO cycle are uncertain, but wherever possible, conservative assumptions have been made that would lead to overestimated emissions.

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12 50 lb/scf $\cong$ 800kg/m^3
13 Chartered Institution of Building Services Engineers, Energy benchmarks, TM46:2008
14 http://www.eldoradocountyweather.com/canada/climate2/Kingston.html, accessed 25th May 2016

4 RESULTS AND SUMMARY

4.1 EMISSIONS

4.1.1 The summary air emissions inventory for Kingston Airport for 2015 and a projected inventory for 2026 are shown in Table 4-1.

4.1.2 In 2026, emissions from the Airport are expected to be 3953kg NO_X and 99.9kg PM_{10} higher than in 2015. This results from increased emissions from aircraft related sources due to the higher number of movements in 2026, that are partially offset by a reduction in vehicle emissions. Reductions in vehicle emissions are due to improvements in vehicle technology.

4.1.3 Aircraft engine exhaust emissions are the dominant source of pollutants in both years, amounting to 88% of the total for NO_X in 2015 and 92% in 2026. Furthermore, the majority of exhaust emissions occur during climb-out and approach (when the aircraft is airborne), amounting to 55% of total emissions from the Airport in 2025 and 64% in 2026. This is significant since emissions from airborne aircraft make very little adverse contribution to local air quality. That is to say, the emissions have little impact on the concentration of pollutants in ambient air at ground level.

4.1.4 Of the increase in nitrogen oxide emissions, approximately 68% is attributable to increased aircraft movement in the air, 15% to the increased emissions from runway sources and 12% to increased emissions from taxi-ing and at the gate.

4.1.5 Total emissions of particulate matter as PM_{10} are significantly lower than those of NO_X. This is consistent with inventories at other Airports which conclude that Airports are not a significant source of primary particulate matter[15].

4.2 SUMMARY

4.2.1 The increase in activity at Kingston Airport is expected to increase emissions from the Airport by 3953kg NO_X and 99.9kgPM_{10} between 2015 and 2026. These increases amount to 120% and 100% of current emissions.

4.2.2 The increases can be put in context by comparing them to total emissions generated within the province of Ontario[16].

4.2.3 Total emissions of NO_X and PM_{10} from sources in Ontario in 2014 were 373,711 tonnes and 1,390,039 tonnes respectively. The total emissions from Kingston Airport in 2026 amount to 0.0019% and 0.000014% of these totals. Moreover, 2026 emissions from Kingston Airport amount to 0.024% and 0.060% of the total emissions from air transportation within Ontario. Clearly, the total emissions in both 2015 and 2026, and by inference the change in emissions with Airport expansion, are negligible on the provincial scale.

[15] Primary particulate matter is emitted directly from the source; Secondary particulate matter can form as a result of chemical reactions from emissions of nitrogen oxides and other compounds. Secondary particles are not, however, considered within emissions inventories.

[16] Air Pollutant Emission Inventory Report 1990 - 2014, Environment and Climate Change Canada,

4.2.4 At the local scale, the increase in NO_X emissions is equivalent to the annual emissions from 3393 typical cars[17]. Across Ontario, there were 11,438,574 vehicle registrations for a population of 12,851,821[18]. Assuming similar vehicle ownership rates in Kingston itself (population 117,210 in 2006), 3393 cars will represent less than 3.8% of vehicles within the City.

Table 4-1 Air emissions inventories for Kingston Airport for 2015 and 2026

Source		Nitrogen Oxides 2015 (kg/yr)	Nitrogen Oxides 2026 (kg/yr)	PM_{10} 2015 (kg/yr)	PM_{10} 2026 (kg/yr)
Runway					
	Take-off roll	322.0	830.0	8.1	20.7
	Landing roll inc brake & tire	120.8	223.8	8.1	12.2
In Air (to 1000ft)					
	Climb-out	1194.0	3341.7	29.9	83.5
	Approach	422.7	968.6	10.6	24.2
Taxi					
	In and Out	401.5	631.7	10.0	15.8
Gate					
	Start Up / Shut Down	429.2	696.2	10.7	17.4
	Ground Support Equipment	4.0	5.7	0.3	0.4
	Airside Vehicles/Plant	97.6	131.6	5.2	7.2
Surface Access					
	Landside Vehicles	138.5	48.3	16.9	18.1
Energy Plant					
	Space Heating	153.8	359.4	-	-
Total (kg/yr)					
		3284.1	**7237.1**	**99.7**	**199.6**

4.2.5 The Ministry of the Environment and Climate Change monitor local air quality across Canada. In Kingston, air quality in monitored at 23 Beechgrove Lane, a site to the south-west of the urban centre. Concentrations of nitrogen dioxide were well within Canadian standards in 2014[19]. The maximum monitored 24hr concentration of NO_2 was 15ppb, significantly lower than the 100ppb standard, and a maximum 1hr concentration of 45ppb, well within the 200ppb standard. Concentrations of $PM_{2.5}$ were generally within the 24 hour reference level of 28µg/m^3 and marginally exceeded the level for just 1 day (30µg/m^3).

4.2.6 In Kingston, the principal source of NO_X (and NO_2) is transportation. As such, ambient air quality in the immediate vicinity of the Airport is likely to be similar to that monitored at Beechgrove Lane – both sites are suburban areas on the south-western outskirts of the main urban zone.

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[17] Passenger cars are typically driven 16,000 – 24,000 km per year in Canada, http://www.njc-cnm.gc.ca/doc.php?did=605&lang=eng

[18] http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/trade14b-eng.htm, accessed 25th May 2016

[19] Air Quality in Ontario 2014 Report, Ministry of the Environment and Climate Change

4.2.7 The increase in emissions between 2015 and 2026 equates to 10.3kg/day of NOx which is equivalent to the current NOx emissions from vehicles on a 3km stretch of Highway 33 through Kingston[20]. This is less than the total length of the runways and hardstanding at the airport. For PM_{10}, the increase equates to vehicle emissions from less than 1km of the highway. The majority of airport-related emissions occur in the air, on the approach to the airport and on the flight path during climb out. As noted previously, these will have little impact on ambient pollution levels. Notwithstanding this observation, if it is assumed that the airport-related emissions are concentrated on the runways, the nearest receptors lie over 200m away from the source of the emissions and it is widely acknowledged that the air quality impact of roads is negligible at distances greater than 200m from the road[21].

4.2.8 Overall, therefore, and taking into consideration:

- The existing good air quality in Kingston
- The small magnitude of the increase in emissions (<3.8% of local emissions from transportation)
- The increase in emissions being dominated by in-air emissions and
- The distance between the nearest properties and airport-related emissions sources

it is concluded that the increased activity at the Airport by 2026 will have an imperceptible impact on the exposure of the local population to air pollution.

[20] http://www.raqsb.mto.gov.on.ca/techpubs/TrafficVolumes.nsf/fa027808647879788525708a004b5df8/f51986ea499a13b08525745f006dd30b/$FILE/Provincial%20Highways%20Traffic%20Volumes%202010%20AADT%20Only.pdf, accessed 2nd June 2016; Highway 33 – Collins Bay Road to Coronation Blvd = 13,500 vehicles in 2010.

[21] For example, Highways Agency, UK, Design Manual for Roads and Bridges only requires assessment of impacts up to 200m from roads, including motorways with over 100,000 vehicles per day. http://www.standardsforhighways.co.uk/dmrb/vol11/section3/ha20707.pdf

Appendix A

AIRCRAFT DATA

Table A-1 Runway Assignments 2015 (Itinerant and Local Movements for an average day)

Aircraft	Movements per day	Runway 01-19				Runway 07-25			
		Arrival (01)	Arrival (19)	Departure (01)	Departure (19)	Arrival (07)	Arrival (25)	Departure (07)	Departure (25)
DHC830	1.36	0.06	0.39	0.37	0.13	0.02	0.21	0.08	0.09
BEC190	14.59	1.59	4.60	3.38	2.83	0.27	0.71	0.26	0.94
CNA441	3.20	0.23	0.96	0.80	0.31	0.18	0.28	0.08	0.35
BEC58P	3.44	0.36	0.73	0.45	0.43	0.19	0.43	0.23	0.62
CNA172	51.93	3.52	10.46	4.57	8.16	4.16	7.89	3.99	9.18
C130	0.14	0.01	0.05	0.03	0.04	0.00	0.00	0.00	0.00
CL601	1.92	0.26	0.64	0.46	0.42	0.02	0.04	0.01	0.07
Totals	**76.57**	**6.0**	**17.8**	**10.1**	**12.3**	**4.8**	**9.6**	**4.6**	**11.3**

Source: WSP|Parsons Brinckerhoff & Kingston Airport

Table A-2. Runway Assignments 2026 (Itinerant and Local Movements for an average day)

Aircraft	Movements per day	Runway 01-19				Runway 07-25			
		Arrival (01)	Arrival (19)	Departure (01)	Departure (19)	Arrival (07)	Arrival (25)	Departure (07)	Departure (25)
DHC830	10.2	0.7	3.3	2.2	0.9	0.6	0.5	0.3	1.6
BEC190	9.2	0.6	3.0	2.0	0.8	0.6	0.5	0.3	1.5
CNA441	3.3	0.2	1.1	0.7	0.3	0.2	0.2	0.1	0.5
BEC58P	2.1	0.1	0.7	0.5	0.2	0.1	0.1	0.1	0.3
CNA172	82.3	6.2	16.9	9.9	11.1	7.0	11.1	6.2	14.0
C130	0.3	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0
CL601	0.7	0.1	0.3	0.2	0.1	0.0	0.0	0.0	0.0
Totals	**108.0**	**7.8**	**25.3**	**15.6**	**13.5**	**8.5**	**12.4**	**6.9**	**18.0**

Source: WSP|Parsons Brinckerhoff & Kingston Airport

Table A.3 Take off and Landing distances and speeds

	Stall Speed (kts)	Landing Distance (from aiming point) (m)	Approach from 50ft (m) inc landing roll	Take Off Roll (m)	Climb to 50 ft (m) inc take-off roll	TO Speed (m/s)	Landing Speed (m/s)	Time in model TO (min)	Time in model Landing (min)	Climb out to 1000ft (min)	Approach from 1000ft (min)	Maximum Take-Off Weight (kg)
DHC830	74	**457**	**1010**	**769**	**1099**	72.0	78.0	**0.5**	**0.5**	**2.5**	**2.5**	16,874
BEC190	88	**427**	**853**	**797**	**1139**	54.3	58.9	**0.5**	**0.6**	**2.5**	**2.5**	7,764
CNA441	76	**334**	**572**	**544**	**751**	46.9	50.8	**0.5**	**0.5**	**2.5**	**2.5**	4,464
BEC58P	84	**457**	**594**	**427**	**701**	51.9	56.2	**0.5**	**0.5**	**2.5**	**2.5**	2,313
CNA172	51	**168**	**395**	**288**	**514**	31.5	34.1	**0.5**	**0.5**	**2.5**	**2.5**	1,111
C130	100	**427**	**777**	**1003**	**1433**	61.7	66.9	**0.5**	**0.7**	**2.5**	**2.5**	70,300
CL601	119	**427**	**842**	**1152**	**1646**	73.5	79.6	**0.4**	**0.7**	**0.0**	**0.0**	43,100

** Time in mode adjusted to FOI recommended time for emissions calculation if greater than calculated time

Source: Take-off and Landing speeds calculated from stall speed specified by manufacturers for each aircraft; Distances calculated assuming constant acceleration from standing to take-off speed or landing speed to stationary; Climb out and approach distances based on glide path at 3% slope. Maximum take-off weight from manufacturers.

Table A.4a Engine Emissions Data

Mode	PT6A67			TS10-520-L			T56-A-15			CF34-3A		
	Time in Mode (s)	Fuel Flow (kg/s)	NOX (g/kg)	Time in Mode (s)	Fuel Flow (kg/s)	NOX (g/kg)	Time in Mode (s)	Fuel Flow (kg/s)	NOX (g/kg)	Time in Mode (s)	Fuel Flow (kg/s)	NOX (g/kg)
Start Up (7%)	900	0.0192	1.8821	900	0.00142	1.23209	900	0.04372	3.82460	900	0.0496	3.8200
Taxi Out (7%)	336	0.0192	1.8821	270	0.00142	1.23209	210	0.04372	3.82460	468	0.0496	3.8200
Take Off (100%)	30	0.0918	7.1872	30	0.01656	2.04322	30	0.21052	12.40306	24	0.4070	11.6100
Climb Out (85%)	150	0.0834	6.7765	150	0.01156	4.71275	150	0.18982	10.59599	78	0.3343	10.1400
Approach (30%)	186	0.0491	4.7230	180	0.00594	10.47278	192	0.11306	6.98185	108	0.1190	6.8600
Taxi In (7%) 2015/2026	486 / 564	0.0192	1.8821	342 / 384	0.00142	1.23209	510 / 594	0.04372	3.82460	510 / 594	0.0496	3.8200

Table A.4b Engine Emissions Data (cont)

Mode	IO-360-L2A			TPE331-8			PW123		
	Time in Mode (s)	Fuel Flow (kg/s)	NOX (g/kg)	Time in Mode (s)	Fuel Flow (kg/s)	NOX (g/kg)	Time in Mode (s)	Fuel Flow (kg/s)	NOX (g/kg)
Start Up (7%)	900	0.00171	1.95081	900	0.01263	3.15916	900	0.04292	3.08023
Taxi Out (7%)	294	0.00171	1.95081	264	0.01263	3.15916	900	0.04292	3.08023
Take Off (100%)	30	0.01814	2.77221	30	0.06370	11.60220	30	0.29571	19.81614
Climb Out (85%)	174	0.01354	4.41500	150	0.05956	11.39685	150	0.26670	17.86533
Approach (30%)	192	0.00838	3.79895	180	0.03598	10.78080	180	0.13029	9.75060
Taxi In (7%) 2015/2026	528 / 576	0.00171	1.95081	402 / 474	0.01263	3.15916	402 / 474	0.04292	3.08023

Source: FOI and ICAO databases (as reported in EDMS)