Billy Bishop Toronto City Airport

PORTER AIRLINES PROPOSAL REVIEW

FINAL REPORT

27 NOVEMBER 2013

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01. EXECUTIVE SUMMARY

Porter Airlines Inc. (Porter Airlines) announced on 10 April 2013 the conditional purchase of 12 Bombardier CS100 aircraft (CS100) as well as an option for an additional 18 CS100 aircraft subject to the amendment of two key provisions of the 1983 Tripartite Agreement:

1. The lifting of the current prohibition of jet aircraft operations at Billy Bishop Toronto City Airport (BBTCA).
2. An authorization to lengthen the runway by 168m at both ends of the airfield into the water. [1]

A request to formally review the Porter Airlines proposal was considered by the Executive Committee of the City of Toronto on April 23, 2013 and formally adopted with amendments by the City Council on 7 May 2013. [2]

Airbiz Aviation Strategies Ltd. (Airbiz) was commissioned by the City of Toronto (City) on 22 May 2013, to assist City staff with technical analysis of the request by Porter Airlines to permit jet-powered aircraft at BBTCA. Airbiz is an independent international specialist aviation consultancy servicing airport owners, operators, investors, airlines, government agencies and other aviation stakeholders. [3]

The Airbiz review of the Porter Airlines proposal was conducted based on a review of the materials provided within the Porter Airlines proposal as well as consultations with stakeholders associated with this proposal. The information was reviewed against industry regulations, international best practices and international case studies. The executive summary provides a synopsis of each of the critical areas of consideration and is followed by a description of the findings based upon the assessment conducted.

On 3 September 2013, Porter Airlines made a second request to the City of Toronto which included a 200m extension into the water at both ends of the airfield.[4]

In addition to the comparative review of this second proposal, other tasks were commissioned by the City of Toronto to review additional considerations associated with the Porter Airlines proposals.

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[1] Porter Airlines Press Release, 10 April 2013

[2] Letter from Robert J. Deluce, President and CEO, Porter Airlines Request from Porter Airlines for Exemption to Commercial Jet Ban at Billy Bishop Toronto City Airport, 22 April 2013

[3] http://www.airbiz.aero

[4] Porter Option Letter, 3 September 2013

AIRCRAFT

The Bombardier CS100 operational performance was reviewed based on preliminary information, as the aircraft is still in the testing phase. Several comparable aircraft were identified for comparison within this review to assess their ability to conduct operations at BBTCA, including aircraft that are scheduled to enter service by the end of the decade (2020) using the same engine technology as the CS100 and smaller regional jets that are already in service.

The runway length requirement provided by Bombardier, and supported by Porter Airlines within their proposal, would allow the CS100 to undertake unrestricted operations except under limited conditions where a combination of a high load factor, high temperature and long range destination is involved.

In consultation with Porter Airlines, Bombardier has provided a guarantee that they would meet or better the Tripartite Agreement's allowable cumulative noise level of 259.5 EPNDB. Bombardier has stated that they expect aircraft compliance tests to be completed in May, 2014. The information disclosed at this stage of the testing process (static engine tests and flight tests) for the Bombardier CS100 is trending in line with previous information and statements made by the manufacturer. However, formal confirmation of the compliance of the CS100 to the Tripartite Agreement noise limits will only occur at the outcome of the certification process which is presently expected to occur in May, 2014.

With regard to air quality, a preliminary review of literature confirms that the CS100 will meet the most current international emissions standards (CAEP/6).

CAPACITY ASSESSMENT

A key determinant of BBTCA's capacity is the existing slot cap on scheduled movements. The slot cap is in place in order to ensure the airport's overall compliance with the terms of the Tripartite Agreement. Since the Tripartite Agreement does not specify the number of slots, this number is imposed by the Toronto Port Authority based on operational conditions, the fleet mix in operation, the noise modelling tool and the noise assumptions used by Transport Canada. For the purposes of this review, a base assumption, agreed to by the City of Toronto staff and based on advice from the Toronto Port Authority that no changes are being considered, is that the 202 slot cap will remain as a constraint. Future studies may undertake additional noise modelling as more information becomes available on the noise levels of the CS100 or other jet aircraft compliant to the Tripartite Agreement (potentially the MRJ, A319neo, B737max7 and the Embraer E2).

The proposed extension of runway 08-26 will not increase aircraft movement capacity, but provides the opportunity for larger jet aircraft to operate at BBTCA. Aircraft with more seating capacity can increase the busy hour passenger demand and will require increased capacity of terminal and groundside facilities. Furthermore, the Dash8-Q400 will now be able to operate at Maximum Take-Off Weight (MTOW) under most conditions, allowing for a combination of higher passenger payloads and a longer range for this aircraft.

As runway extension is not associated with a parallel taxiway modification, aircraft requiring the full length of Runway 08-26 on take-off would effectively need to backtrack while on the runway to the runway end, which would reduce the hourly capacity of the runway to an extent that will be dependent on the timing of operations requiring the full runway-length. The need for an associated taxiway system should be confirmed with the TPA.

Under existing operations and assuming an 85% load factor, an estimate of the annual airport capacity is approximately 3.8 million passengers. Of those passengers, it is assumed that 25% are transferring, which results in approximately 1 million annual transferring passengers and approximately 2.8 million annual passengers who would interface with groundside facilities at BBTCA.

The existing hourly capacity is estimated at approximately 870 passengers per hour based on the current layout of 10 Q400 aircraft gates. Taking into account an average transfer rate of 25% the demand on groundside would be approximately 650 passengers per hour, each way.

When considering the introduction of the CS100 on 25% of the slots and assuming an 85% load factor, this leads to an incremental increase in capacity of 500,000 passengers to 4.3 million per year, which corresponds to a low growth scenario per the assumptions used in the HLT Advisory Report[5]. Assuming that the introduction of the CS100 would lead to an increased utilization of available slots during the weekend, the annual capacity of the airport could grow to 4.6 million and 4.8 million passengers under a medium and high growth scenario respectively per HLT Advisory assumptions. During the busy periods, the ability to operate up to 4 CS100 concurrently could increase capacity to approximately 1,240 passengers per hour in each direction (910 passengers O/D[6]), which represents an increase of approximately 50%. This scenario would result in the need to upgrade terminal facilities to enhance the total processing rate of key facilities. The ability to expand existing passenger terminal facilities to the north and south in incremental phases appears to have a nominal impact on the adjacent areas. Further expansion capacity also appears to exist within the current footprint of the terminal building. However, additional planning is required to determine the exact extent of the impact of the increased passenger

[5] Economic Impact Considerations of an Expanded Billy Bishop Toronto City Airport

[6] Origin/Destination passengers – Passengers that Toronto City Centre is the point of departure or arrival.

demand on the current facility, apron and adjacent uses (ie: general aviation). On groundside, the busy hour demand associated with CS100 operations would have exceeded the capacity of the ferry terminal without the use of the pedestrian tunnel, which becomes essential in eliminating the ferry service capacity constraint.

INFRASTRUCTURE

Review of the runway specifications was found to be compatible with the type of operations sought from the CS100 as well as comparable aircraft types. However, a change of runway category to Code 3 (from the existing Code 2) will impact the runway strip width, required taxiway separation and height restrictions for aircraft parked at the passenger terminal building. These changes will restrict operations on Taxiway Delta and prevent the CS100 from parking on the south side of the passenger terminal building.

The runway length required to enable commercial operations varies significantly based on a range of factors. Because of the variability of payloads and environmental conditions, it is complex and costly to plan for all potential operational occurrences of an aircraft. The preliminary information available for the Bombardier CS100 confirms the ability of this aircraft to operate within the parameters of the proposed runway extension under standard conditions and subject to the final declared distances.

Obstacles Limitation Surfaces (OLS) define the limits to which objects may project into the airspace. BBTCA currently operates with exemptions from Transport Canada with regard to the OLS approach surfaces. For Runway 08, the exemption allows the approach surface at 4.8%. For Runway 26, the exemption allows the approach surface at 6.38%. Transport Canada has not disclosed the implications of a change to Code 3 operations on these existing exemptions. The proposed layout as set-out in the Porter Airlines' Proposal #1 retains the approach surfaces at their existing locations which would maintain the existing depth of the Marine Exclusion Zone (MEZ) subject to the existing approach exemptions being confirmed by Transport Canada. However, some buoys would have to be moved laterally to account for the lateral displacement of the transitional surfaces. For take-off operations, declared distances (e.g. TORA, TODA) will be confirmed with Transport Canada to ensure that appropriate clearances from obstacles are also provided.

In 2010, Transport Canada tabled NPA 2010-012 with the objective to harmonize Canadian Standards (TP312) with regard to Runway End Safety Areas (RESA) with international standards (ICAO Annex 14) which will make the 90m RESA mandatory for runways 1,200m or longer. The use of a portion of the RESA provides additional length for take-off operations which is recommended procedure within most regulatory jurisdictions. The CS100 was found to have smaller jet blast impacts compared to current generation aircraft due to the increased engine air bypass ratio of the geared Turbofan. However, associated jet velocities may still impact harbour navigation and should be reviewed for the CS100 and other jet aircraft likely to operate at the BBTCA to confirm whether there is a need for mitigation measures.

The widening of the runway strip will impact clearances to Taxiway D making it unusable during Runway 08/26 operations. This has the potential to decrease the overall runway utilization, especially during peak hours of operation unless a new taxiway is associated with the runway extension proposals.

The apron used for aircraft parking will be affected by the present proposal. A change of the runway code from 2 to 3 will lead to a wider runway strip requirement and, therefore, the OLS transitional surface will shift towards the existing apron preventing the CS100 from being parked at the gates on the south side of the passenger terminal building leaving the operation of up to 4 CS100 aircraft gates on the West and East apron areas. Additional study on the transitional surfaces will be warranted as specific aircraft parking plans are developed. General Aviation (GA) parking areas should also be reviewed to determine the impact that alternative aircraft parking plans may have on them.

On the western and eastern end of the passenger terminal building, the CS100 will require a realignment of the existing gates to allow for appropriate wingtip clearances to be maintained. Furthermore, the operation of the CS100 aircraft during busy periods (i.e. peak passenger demand) will require the passenger terminal building to be expanded to meet the anticipated increase in demand levels as the terminal traffic grows.

The CS100 likely has an aircraft classification number (ACN) in excess of the pavement rating published at the BBTCA. More detailed study on required pavement upgrades should be undertaken. A detailed study on required pavement upgrades is recommended for the existing runway, taxiway and aprons once additional information is available from the aircraft manufacturer(s).

NOISE IMPACTS

Bombardier has provided a guarantee to Porter Airlines that it will, as a minimum, meet the cumulative EPNDB levels (259.5) set in the Tripartite Agreement. However, formal confirmation of the CS100 compliance to the Tripartite Agreement also requires the certification of the noise levels at each measurement point (Approach, Lateral and Flyover) which will not be completed until May, 2014 (based on advice received from Bombardier and Porter Airlines).

Other comparable existing and future aircraft were considered within the scope of this review. It was found that although smaller regional jets (37-50 seats) are able to comply, existing narrowbody jets operating in Canada are unable to meet the noise limits set within the Tripartite Agreement. However, future aircraft planned for entry in service before the end of the decade such as the Mitsubishi MRJ, the A319neo, B737max7 and Embraer E2 may meet the Tripartite Agreement noise limits upon certification. A complete lifting of the ban on jet aircraft may also allow smaller general aviation jet aircraft to operate at BBTCA. Some very light jets (VLJ) such as the Eclipse 500, Cessna 510 and Embraer Phenom 100 would be able to operate at BBTCA without lengthening of Runway 08-26.

Recent annual noise studies commissioned by Transport Canada[7] have also confirmed compliance to the NEF noise exposure forecasts contained in the Tripartite Agreement. The cap of 202 movements on commercial operations is imposed by the Toronto Port Authority as a means to ensure that this condition set in the Tripartite Agreement is not breached. At present it is not possible to reliably assess the impact of the CS100 aircraft on compliance to the contours in Schedule A of the Tripartite Agreement. Until an assessment can be made based on the revised commercial fleet and operational patterns, the current cap of 202 movements is assumed to remain an adequate interpretation of the Tripartite Agreement noise exposure compliance levels, especially as the CS100 is expected to be certified with noise levels similar to the Dash8-Q400.

For the purpose of assisting the Health Impact Assessment, noise modelling surrogate was developed for a Tripartite Agreement Compliant jet aircraft using the Boeing 737-700 as a proxy.

60 maintenance engine run-ups were conducted for the Dash8-Q400 at BBTCA between October 2012 and September 2013. Tests occurred near the Runway 33 threshold between 645am and 1100pm. Pratt & Whitney expect a significant reduction in maintenance engine run-ups for the CS100 compared to the Dash8-Q400.

GENERAL AVIATION

General Aviation activities were found to be generally unaffected by the Porter Airlines proposal. The most recent review of the commercial aircraft movements slot allocation assumed over 380 general aviation movements on a busy day by a range of aircraft which is not affected by this runway extension proposal. Additional spatial constraints may occur on aprons as a result of the categorization of Runway 08-26 as Code 3, which will increase the clearances laterally from the runway and from the additional space required for parking the CS100 or similar aircraft. Plans to increase the footprint of the passenger terminal building could over time add constraints on general aviation airside activities.

The proposed runway lengthening of Runway 08-26 from 1,216m to 1,569m will not directly affect

[7] Jacques Savard (2010), InterVISTAS (2011) and Genivar (2012)

general aviation operations. The integrity of the two (2) cross-runways are maintained which will enable small aircraft operators to retain access to runways providing optimal crosswind coverage.

On the aprons, plans to increase the footprint of the passenger terminal building could, over time, add constraints on general aviation airside activities subject to the review and approval of the final aircraft parking plans, a review of pushback and ramp operations as proposed by Porter Airlines.

Under a scenario where all jet operations compliant with the Tripartite Agreement noise levels are allowed to operate at BBTCA, a lift of the ban on jet operations would immediately allow small general aviation jet aircraft such as Very Light Jets (e.g. Cessna Mustang 510, Embraer Phenom 100 and Eclipse 500) to operate from the existing runway.

INTERNATIONAL CASE STUDIES

Several urban airports comparable in size and traffic to BBTCA, including those along waterfront areas, were benchmarked to identify their operational specifications. These include key infrastructure, operational restrictions and urban interface considerations. The airports reviewed in Bromma (Sweden), London City (United Kingdom) and Belfast City (United Kingdom/Northern Ireland) were found to allow jets, but to be operating under strict operational constraints including hours of use and limits on aircraft movements. Initiatives aimed at integrating these airports with their respective urban public transit system were also identified.

COST ESTIMATES

The cost estimate relates solely to the proposed Runway 08-26 extension at both ends for the 168m option (Proposal #1) and for the 200m option (Proposal #2). Total order of magnitude cost estimate were assessed at $80 million (Proposal #1) and $92 million (Proposal #2). The potential impacts identified throughout this review may result in additional costs and they are excluded from the estimates within this document. The exclusions include, but are not limited to, upgrades of existing facilities such as runways, taxiways, apron, the passenger terminal building and aviation support facilities to accommodate jet aircraft.

Further work on the conditions of existing infrastructure such as runways, taxiways, aprons and the passenger terminal building are expected to lead to additional costs. Financial feasibility of this proposed expansion has yet to be addressed as additional costs that may be indirectly associated to the runway extension have not been fully identified.

AIRSPACE CONSIDERATIONS

Two proposals were reviewed over the course of this study.

Proposal 1 involves displacing the landing threshold by 60m without impacting the location of the approach splays. However, the widening of the runway strip due to the Runway Code 3 classification leads to a lateral displacement of some of the existing buoys.

Proposal 2 leaves the landing threshold at its existing location to minimize the lateral displacements of some of the existing Marine Exclusion Zones (MEZ) buoys. By doing so, the take-off run available is increased by 64m but the landing length available is reduced by 28m.

Proposal 1 was the only proposal peer reviewed for the purpose of assessing instrument procedures.

The CS100 aircraft proposed by Porter Airlines is an approach category "C" aircraft. These categories are based upon the normal approach speed of the aircraft. Category C aircraft Glidepath angles (GPAs) for either Instrument Landing System (ILS) or Global Navigation Satellite System (GNSS) vertical guidance approaches are limited to a normal maximum angle of 3.6°.

An exemption is currently granted on the ILS/DME RWY 26 permitting a Glidepath angle (GPA) of 4.8°. This approach is currently in the Restricted Canada Air Pilot (R-CAP) and authorized for only approach Category A and B aircraft. In order for Porter Airlines' aircraft to use a 4.8° GPA approach the exemption must be extended to include Category C aircraft.

Steep approach procedures are used as a means to clear man-made or natural obstacles and to reduce noise impacts in the vicinity of the airport. Approaches of 4.5% or more are deemed steep and require regulatory approval.

The glidepath for the ILS/DME RWY 08 approach is proposed to increase from 3.5° to 3.9° for Proposal #1. A new TP308 exemption would be required to authorize this steeper GPA. The resulting approach if approved would need to be moved from the Canada Air Pilot (CAP) and published instead in the Restricted Canada Air Pilot (R-CAP). This would mean that private IFR aircraft, or aircraft without the required OPS SPEC, would not be authorized to fly this approach leaving the BBTCA without a publicly available ILS as a result. It is understood that for Proposal #2, the glidepath would remain unchanged at 3.5°.

Applications for approval of non-standard instrument approach procedures (IAPs) must be submitted to Chief Air Navigation Services (ANS) Operations Oversight at Transport, Ottawa. Transport Canada is normally quite hesitant to grant exemptions to the design criteria without significant supporting justification as to why such an exemption is "in the public interest" and how an "equivalent level of safety" can be maintained despite the deviation from criteria. Transport Canada's willingness to consider these specific approach parameters should be ascertained before committing significant resources.

There were no speed restrictions on any of the airport's Standard Instrument Departures (SIDs), Standard Terminal Arrival Routes (STARS), approaches, or departures other than the 'C' Category approach issues already discussed. Therefore, except for possible increases in wake turbulence separation, no significant adverse airspace or ATC issues are considered likely to occur.

The Toronto-Pearson Airport and BBTCA are co-dependent with regard to the ability to operate aircraft in the general Toronto Terminal Airspace. However, that is not affected by the proposed lengthening of the runways.

Since the Runway 08/26 capacity is not increased by the lengthening, this proposal will not increase demand on the Toronto Terminal Airspace. Further review of airspace area capacity and operational procedures of both YYZ and BBTCA is required to define areas of co-management.

KEY FINDINGS

The key findings are listed in the table below and are provided as a reference for the primary points of concern at this stage of the study:

Chapter	Topic	Key Findings
04 Design Aircraft		
	General Aviation Jet Aircraft	Current smaller General Aviation jet aircraft will meet the noise requirements within the Tripartite Agreement.
	Commercial Jet Aircraft	Current narrowbody jet aircraft will not meet the noise requirements within the Tripartite Agreement .
		Some current regional jet aircraft meet the noise requirements within the Tripartite Agreement.
		Future commercial aircraft comparable to the CS100 are expected to be able to meet the noise requirements within the Tripartite Agreement.
	Bombardier CS100	CS100 performance standards are predicated on information from Bombardier.
		Static engine test results and preliminary flight test results were disclosed and found to be in compliance with the limits set in Tripartite Agreement.
		The CS100 will not be certified by Transport Canada until May 2014 (based on current information).
05 Capacity Assessment		
	Slot Cap	Is assumed to remain at 202 movements for the purpose of this study but could change over time based on changing operational conditions, fleet mix and noise modelling methodology.
	Runway	The proposed runway extension does not increase runway capacity.
	Taxiway	Backtracking on runway by aircraft due to restrictions on Taxiway D would restrict runway capacity during busy hours unless a compliant parallel taxiway is provided as part of the extension.
	Annual Capacity	Annual passenger processing capacity is projected to increase from 3.8 million to 4.3 million passengers if commercial jet aircraft are allowed at BBTCA and the slot cap remains unchanged.
	Busy Hour Capacity	During busy hours, one-way passenger movement capacity could increase from 870 to 1,240 passengers (including transferring passengers) if operations are unrestricted by scheduling caps.
	Terminal	Terminal facilities would require upgrades to passenger processing facilities if CS100 operates during busy periods.
	Apron	The current 10 apron stands are not proposed to be added to within this proposal.
	Groundside	Pedestrian tunnel busy hour capacity exceeds the ferry service capacity and therefore contributes to an overall increase in the airport system busy hour capacity.

Chapter	Topic	Key Findings
06 Infrastructure Requirements		
	Runway Code	Runway 08-26 is expected to be revised from a Code 2 runway to a Code 3 runway under both proposals.
	Runway Usability	Based on a 20 knot crosswind tolerance, CS100 and Dash8-Q400 can operate on Runway 08-26 99.77% of the time, well in excess of international standards (95%).
	Obstacle Limitation Surfaces	Existing OLS exemptions require confirmation from Transport Canada that they can apply for a Code 3 runway.
	Airport Zoning Regulations	Impacts of both proposals on existing Runway 08-26 Airport Zoning Regulations must be confirmed with Transport Canada.
	Proposed Runway Extension	Preliminary information confirms the ability of the CS100 to operate within the parameters of both proposed runway extension proposals.
	Runway End Safety Areas	These are likely to become a requirement at Canadian airports in the near future. It has therefore not been confirmed whether RESAs will be required under the status quo (Runway remains Code 2) but any runway extension project would need to plan accordingly for RESAs.
	Taxiways	Taxiway D is restricted due to the proposed changes which will likely reduce the overall runway utilization at busy hours unless a new taxiway is associated with the runway extension proposals.
	Apron	The apron will require alteration to accommodate the operation of up to 4 CS100 aircraft gates at the West and East apron areas.
	Jet Blast Considerations	CS100 has smaller jet blast impacts compared to current generation aircraft due to the increased engine air bypass ratio of the geared Turbofan. Associated jet velocities may still impact harbour navigation and should be reviewed for the CS100 and other jet aircraft likely to operate at the BBTCA.
	Pavement Strength	The CS100 has an aircraft classification number (ACN) in excess of the pavement rating at the BBTCA. More detailed study on required pavement upgrades should be undertaken.
	Terminal	The terminal will require expansion in a number of areas to accommodate increases in passenger processing capacity.
	Groundside	The commissioning of the pedestrian tunnel will increase groundside capacity and will enhance the passenger flows in and out of the passenger terminal building.

Chapter	Topic	Key Findings
07 Noise Considerations		
	Noise Disclosure	Attempting to correlate noise metrics with impacts on the community is complex as aircraft noise as experienced by an individual is highly subjective.
		Refraction of sound over water and refraction of sound off buildings and water contribute to the complexity of noise propagation in the vicinity of the airport.
	Aircraft Noise	The CS100 is expected to operate at or below the requirements within the Tripartite Agreement.
		It is not possible to reliably assess the impact of the CS100 aircraft on compliance with the NEF contours in the Tripartite Agreement.
		Compliance of CS100 certification noise levels with the Tripartite Agreement noise limits can only be confirmed upon completion of test flights and formal noise certification by Transport Canada.
		Future jet aircraft, comparable to the CS100, are expected to operate at or below the requirements set within the Tripartite Agreement.
		Current small general aviation and regional jet aircraft operate at or below the requirements within the Tripartite Agreement. Health Impact Assessment was conducted based on a Tripartite Agreement Compliant jet aircraft using the Boeing 737-700 as a surrogate.
	Engine Run-Ups	60 maintenance engine run-ups were conducted at BBTCA between October 2012 and September 2013. Tests occurred near Runway 33 threshold between 645am and 1100pm. Pratt&Whitney expect a significant reduction in maintenance engine run-ups for the CS100 compared to the Dash8-Q400.
08 General Aviation		
	GA Operations	GA operations are not expected to be physically negatively affected by the introduction of the CS100 although apron changes could impact GA aircraft parking.
		A runway extension not associated with a taxiway system may lead to a reduction in airfield capacity or lead to the use of intersection departures for smaller general aviation aircraft.
		Type of GA operations could change if jet ban is lifted and small jet aircraft start utilizing the airport.
		The two cross runways remain available for GA activity to provide optimal crosswind coverage.
09 Case Studies		
	General Findings	Jets are allowed at the airports reviewed, but operating under strict operational constraints including hours of use and limits on aircraft movements. Initiatives aimed at integrating these airports to their respective urban public transit system were also identified.

Chapter	Topic	Key Findings
10 Cost Estimate and Financial Feasibility		
	Runway Extension	Estimated cost of $80M (Proposal #1, 168m extension) and of $92M (Proposal #2, 200m extension).
	Pavement Rating	CS100 appears to exceed the pavement rating on existing runway, taxiways and aprons. Additional pavement engineering study may be required to confirm extent of upgrade works.
	Terminal Expansion and apron parking	Requirement, scope and costs were not addressed in this study.
	Financial Feasibility	Several considerations were identified beyond the scope of a runway lengthening into the water at each end which will impact the financial feasibility of this proposal (eg: pavement upgrade, new taxiways, apron upgrades).
11 Airspace Considerations		
	CS100 Airspace Considerations	Category 'C' approach designation based on normal approach speed of the aircraft.
		Normal maximum instrument approach angle is 3.6° for Category C aircraft.
		In order to use a 4.8° GPA approach the exemption must be extended to include Category C aircraft.
		Proposal #1 was the only option peer reviewed and would involve a new TP308 exemption from Transport Canada.
	Toronto Pearson Considerations	Toronto-Pearson and Billy Bishop Airports are co-dependent with regard to the ability to operate aircraft in the general Toronto Terminal Airspace. However, that is not affected by the proposed lengthening of the runways. Approach's protected airspace would only be expended minimally on those missed approach sections already identified which would not have any effect on the total terminal's capacity.
	Proposal #1	Proposal #1 involves displacing the landing threshold by 60m without impacting the location of the approach splays. However, the widening of the runway strip due to the Runway Code 3 classification leads to a lateral displacement of some of the existing buoys.
	Proposal #2	Proposal #2 leaves the landing threshold at its existing location to minimize the lateral displacements of some of the existing Marine Exclusion Zones (MEZ) buoys. By doing so, the take-off run available is increased by 64m but the landing length available is reduced by 28m.
	Steep Approach	Steep approach procedures are used as a means to clear man-made or natural obstacles and to reduce noise impacts in the vicinity of the airport. Approaches of 4.5% or more are deemed steep and require regulatory approval.

Table 1.1 Key Findings

02. SCOPE AND METHODOLOGY

This section outlines the scope of work and methodology used for this Study as agreed to by the City of Toronto. The purpose of this Study is to provide technical background information to the City of Toronto in order to assist them in their review of Porter Airlines' request to lift the restriction on jet operations and extend the main Runway 08-26 at Billy Bishop Toronto City Airport (BBTCA).

SCOPE OF WORK

This study addresses the approved scope of work set out below:

1. To determine the airport ultimate capacity of the BBTCA (YTZ) through the examination of the airside and terminal components and terms and conditions of the Tripartite Agreement and also taking into account Bombardier CS100 or similar aircraft operating from the airport and the current noise regulations contained within the Tripartite Agreement.

2. Examination of the Bombardier CS100 aircraft, its performance capabilities, noise profile, requirements for operation at BBTCA (YTZ), air quality impacts, and identification of comparable current or upcoming jet aircraft with similar performance profiles.

3. Examination of BBTCA (YTZ) airport infrastructure required to support an increase in aeronautical and non-aeronautical operations, compatibility with current Noise Exposure Forecast (NEF) Contour Standards, safety, and changes to take-off and landing approach surfaces, protected airspace and marine exclusion zones.

4. Examination of potential noise and environmental issues due to the expansion of the airport to permit jet aircraft such as Bombardier CS100 or similar aircraft.

5. Examination of the impact of the proposed Runway End Safety (RESA) standards on BBTCA (YTZ), the configuration, required extension into Lake Ontario and the Inner Harbour and Marine Exclusion Zone (MEZ), and inclusion of runway requirements for Bombardier CS100 or similar aircraft.

6. Examination of the impact on General Aviation operating at BBTCA (YTZ) due to the introduction of CS100 and other jet aircraft to the airport lands if Bombardier CS100 or other jet aircraft were introduced.

7. Identification and examination of potential conflicts between the airspace of an expanded BBTCA (YTZ) with jet aircraft operations and the protected airspace and terminal control area around Pearson International Airport (YYZ) as defined by Nav Canada. Coordination of discussions with NAV Canada and the creation of a framework for resolving the questions related to airspace.

8. Examination of the order of magnitude cost for expansion of the BBTCA (YTZ) airport facilities and resulting airline cost per enplaned passenger and comment on the financial feasibility of the expansion of all operations at BBTCA (YTZ).

9. Examination of other waterfront airports located within urban areas, benefits and drawbacks, and operating limitations placed on them.

10. Any other issues that the City may have identified during the course of the review.

As the process evolved, some tasks were clarified and additional tasks were commissioned by the City of Toronto as follows:

1. Review procedural requirements and impact of engine run-ups at the BBTCA. Review existing TPA noise abatement procedures and review broader industry approaches to noise mitigation and procedural options available to alleviate issues related to engine run-ups.

2. Work with the City in organizing a test flight of the CS100 aircraft (contingent on agreement from Bombardier); define the parameters and findings that the City wishes to attain from the test; attend the test flight; record any notes from the event, and report on detailed findings provided by Bombardier.

3. Conduct a peer review of the TPA's submission to Transport Canada for the steep approach permission for BBTCA. Provide a "delta" differential in the noise levels of standard versus steep

approaches. Provide comment on steeper approach's impact on marine navigation, noise, air quality/pollution, and recreational uses.

4. Provide a summary of potential alternative metrics that could be used to regulate operations at the BBTCA.

5. Review the TPA's Noise Management Office operations and monitoring software and provide recommendations for improving communication with the public and stakeholders.

6. Review compatibility of Small Commercial Jet Aircraft at the BBTCA.

7. Develop a Noise Modelling Surrogate based on a Tripartite Agreement Compliant aircraft (i.e. aircraft with certification noise levels based on the Tripartite Agreement noise limits).

METHODOLOGY

This review was conducted primarily based on a review of material associated with the Porter Airlines proposal as well as meetings with main proponents associated with this proposal. The information was reviewed against industry regulations and best practices, as well as through international case studies. Public consultations were conducted following the delivery of the initial findings reports which led to the addition of elements to the scope of work as advised by the City of Toronto.

REVIEWED MATERIAL

A list of the material reviewed is included in Chapter 14 of this report. The following specific items associated with the Porter Airlines proposals were reviewed during the preparation of this report:

- CS100 Update Presentation, Porter Airlines Inc.
- Flight Paths Presentation, Porter Airlines Inc.
- Runway Presentation, Porter Airlines Inc.
- Aircraft Noise Assessment of Allowing CS100 Flights at Billy Bishop Toronto City Airport, Tetra Tech AMT, May 28 2013
- Porter Airlines Runway 08-26 Extension Study Billy Bishop Toronto City Centre Airport, May 24 2013, LPS AVIA Consulting (and subsequent revision dated 29 October 2013)
- TP 308 Impact Study Toronto Billy Bishop Toronto City Airport, May, 2013, Air Navigation Data

    - Map 1: Runway 08-26 Extension, Air Navigation Data
    - Maps 2 & 3: Runway 08-26 Obstacle Assessment, Air Navigation Data
- Canadian Air Pilot Instrument Procedures, NAV Canada
- Summary of Other Airports, Porter Airlines Inc.
- Passenger Forecast, Maintenance and Terminal Presentation, Porter Airlines Inc.
- Porter Options Letter, Porter Airlines Inc.
- Aviation-specific submissions from aviation, airport, community and waterfront groups.

MEETINGS

The following meetings were held over the course of this study:

- 28 May 2013, City of Toronto, HLTA;
- 28 May 2013: Porter Airlines, Toronto Port Authority and Genivar; and
- 25 October 2013: Transport Canada (Noise and NEF contours).

Limited consultations with Transport Canada were undertaken via email with a generic response provided on 11 June 2013 since no formal proposal had been presented to the airport at that time. Follow-up conference calls were conducted to clarify aspects of the proposal or to obtain additional information.

PUBLIC CONSULTATIONS & COUNCIL MEETINGS

The following public consultations were attended by Airbiz staff:

- 4 September 2013, Fort York; and
- 9 September 2013, Metro Hall.

The following council meetings were attended by Airbiz staff:

- 3 July 2013, Executive Committee Meeting;
- 24 September 2013, Executive Committee Meeting; and
- 7 November 2013, Toronto and East York Community Council Sub-Committee Meeting.

03. BACKGROUND

The Billy Bishop Toronto City Airport (BBTCA) was opened in 1939. In 1983, the City of Toronto, Toronto Harbour Commission (now the Toronto Port Authority) and the Government of Canada (Minister of Transport) entered into a Tripartite Agreement for the lease of the airport lands for a term of 50 years.[8] The "Tripartite Agreement" governs the operation of the airport by the Toronto Port Authority and includes restrictions such as:

- A ban on jet aircraft ;
- A ban on expansion of existing runways and construction of new runways; and
- A night curfew (11:00pm to 6:45am).

Porter Airlines started commercial operations in 2006 at BBTCA with a fleet consisting exclusively of Bombardier Dash8-Q400 aircraft flying to regional ports generally within 500 nautical miles (approximately 1,000 km) of Toronto. Air Canada restarted operations from BBTCA in 2011 following the award of 30 slots under a newly introduced slot management scheme.[9] The airport handled over 2.3 million scheduled commercial passengers in 2012 in addition to general aviation operations.[10]
In 2010, following requests from other airlines, the Toronto Port Authority completed a capacity study to assess the number of aircraft movements that could be handled within the noise limits set in the Tripartite Agreement.[11] Based on a scenario which included general aviation operations and considerations of night movements, it was determined that the airport could accommodate 202 daily slots for scheduled commercial aircraft arrivals and departures based on a specific operational scenario. Airbiz Aviation Strategies peer reviewed the report and methodology used and concurred with the

[8] http://www.toronto.ca/legdocs/mmis/2013/cc/bgrd/backgroundfile-58197.pdf
[9] http://www.theglobeandmail.com/report-on-business/air-canada-continental-win-toronto-island-airport-slots/article4323845/
[10] Toronto Port Authority 2012 Year-End Results
[11] BBTCA – Noise Management Study – Interim Report – February 2010

findings of the capacity study.

EXISTING FACILITIES

BBTCA consists of three runways at different orientations (two east-west, one north-south) hence providing optimal wind coverage to general aviation traffic. The following image shows the main existing facilities.

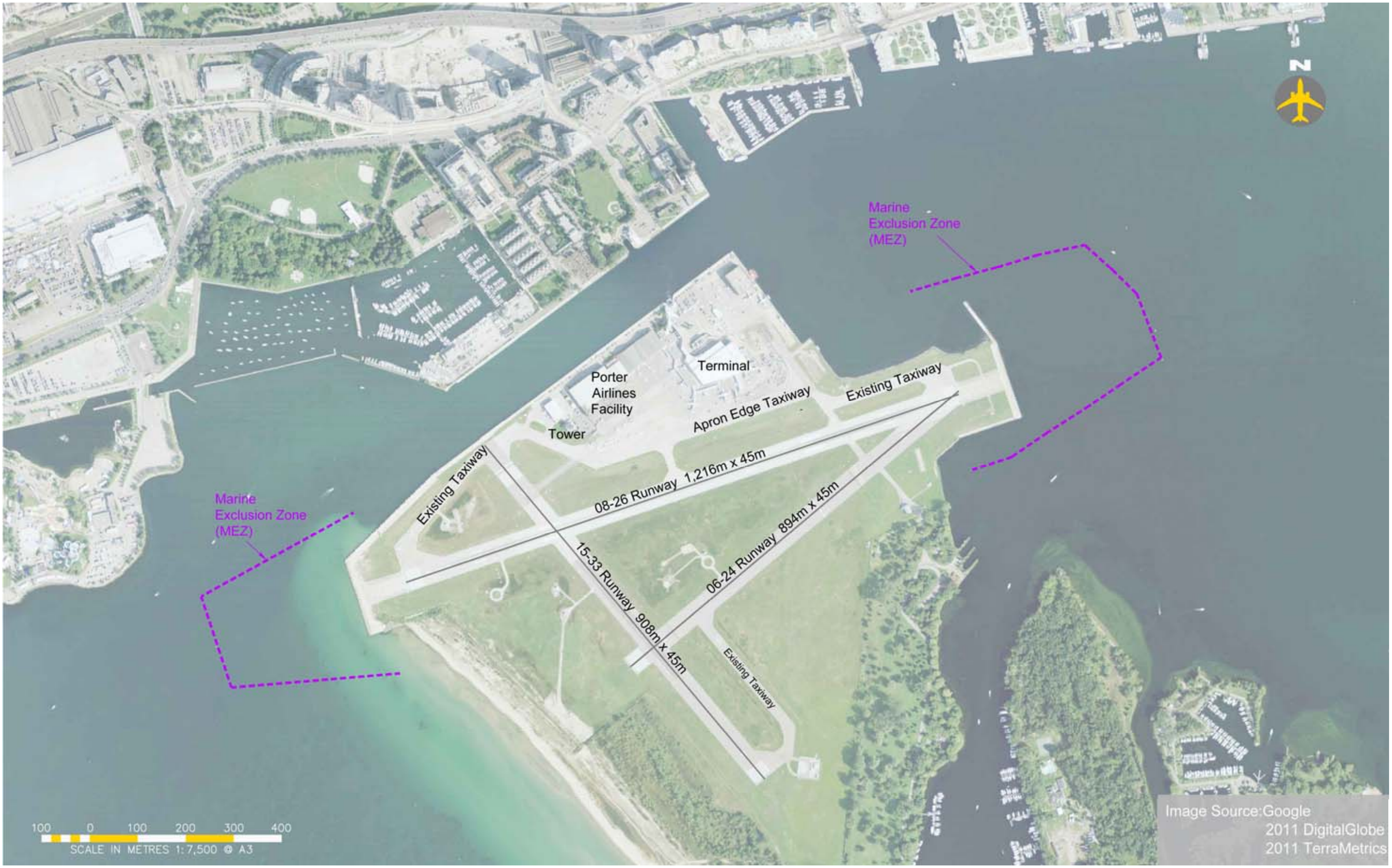

Fig 3.1 Billy Bishop Toronto City Airport – Existing Facilities

HISTORICAL MOVEMENTS

Porter Airlines and Air Canada operate to a range of regional domestic and transborder destinations, generally to and from destinations within 500 nautical miles from the BBTCA due to current restrictions on the size and type of aircraft that may be operated from BBTCA.[12]

The following chart shows the historical passenger movements (origin and destination) at BBTCA by commercial airlines. When including transfer passengers, total traffic increases to 2.3 million passengers (2012).[13]

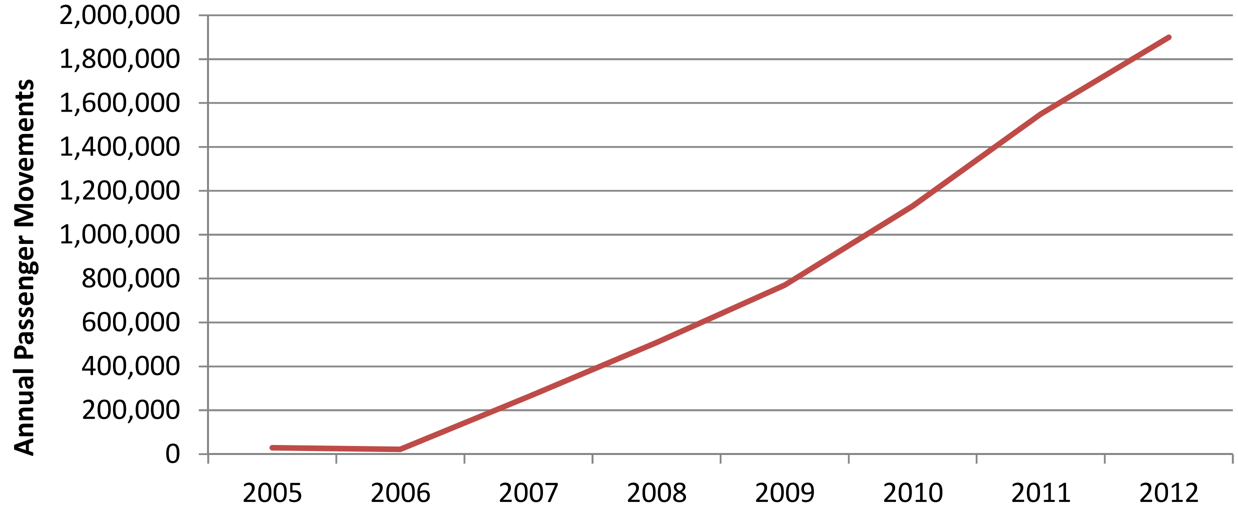

Fig 3.2 Historical Origin/Departure Passenger Movements[14]

The historical passenger movements have shown steady growth since Porter Airlines started operations in 2006. Traffic had previously peaked at 331,000 passengers in 1987 after City Express' relocation from Peterborough to the Toronto City Airport. Following the introduction of services by Air Ontario and the failure of City Express, traffic steadily declined to under 100,000 passengers per year until Porter Airlines

[12] Request from Porter Airlines for Exemption to Commercial Jet Ban at Billy Bishop Toronto City Airport
[13] http://www.bloomberg.com/article/2013-08-23/a4g8spQK0ypc.html
[14] TPA – Annual Reports

entered the market.[15]

Among itinerant movements (flights operating from one airport to another), the following graph shows the progressive growth in turboprop aircraft operations, primarily driven by the expansion of operations by Porter Airlines and the reinstatement of operations by Air Canada in 2011. Local movements are those flights that remain in the vicinity of the airport.

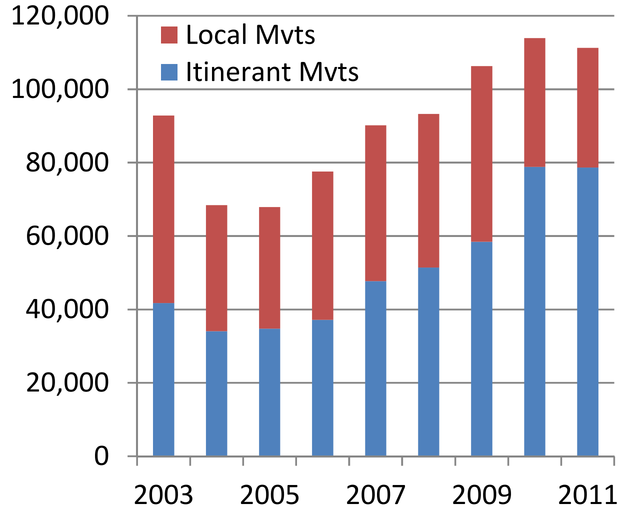

Fig 3.3 Historical Aircraft Movements – Local vs Itinerant

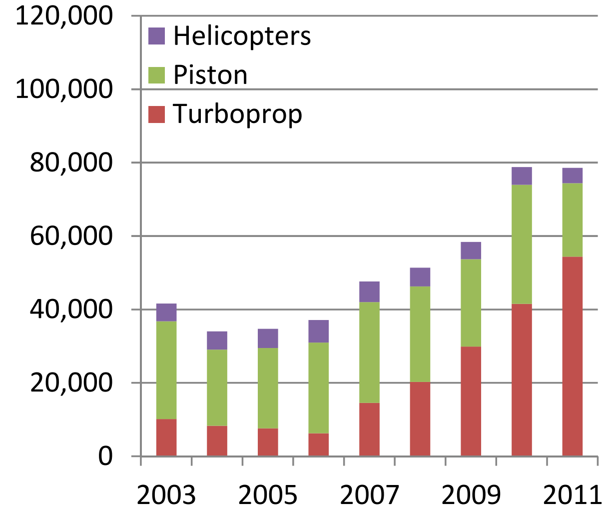

Fig 3.4 Historical Itinerant Movements – By Aircraft[16]

Operations at BBTCA are predominantly driven by the business market. A review of a typical schedule for May 2013 highlights the profile of seats available across a weekday and on weekends. Daily profiles on weekdays highlight the typical business peaks of early morning and later afternoon based on a rolling busy hour.

[15] https://www.torontoport.com/TorontoPortAuthority/media/TPASiteAssets/news/May14_2010AirCanada.pdf
[16] Aircraft Movement Statistics: NAV CANADA Towers and Flight Service Stations: Annual Report (TP 577) 2011

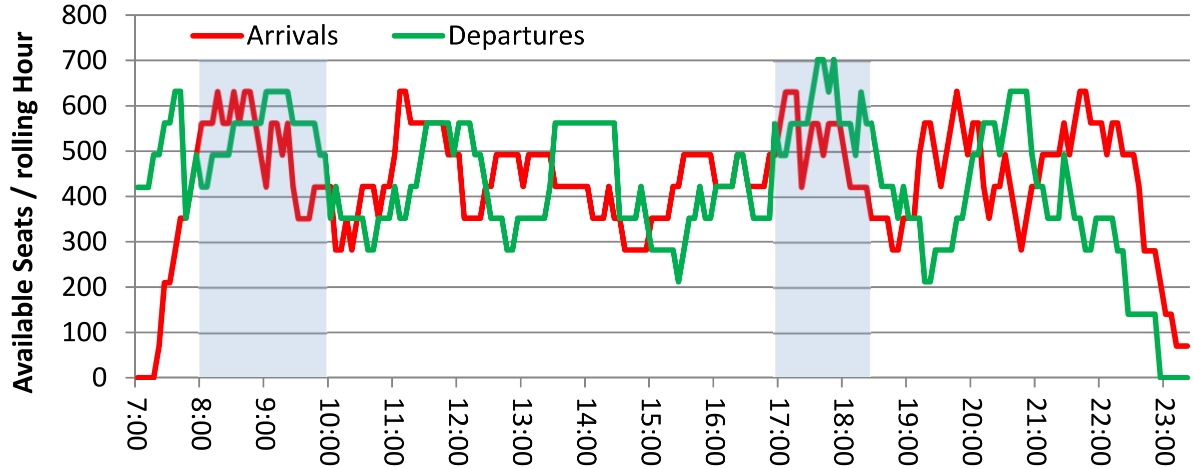

Fig 3.5 Daily Profile – Available Seats (Weekday, May 2013)

The daily profile of seat availability differs over the weekends. It shows operations starting later in the morning with a noticeable reduction in operations between Saturday afternoon and Sunday afternoon. However, Sunday evening is characterised by a surge in operations, especially for arrivals.

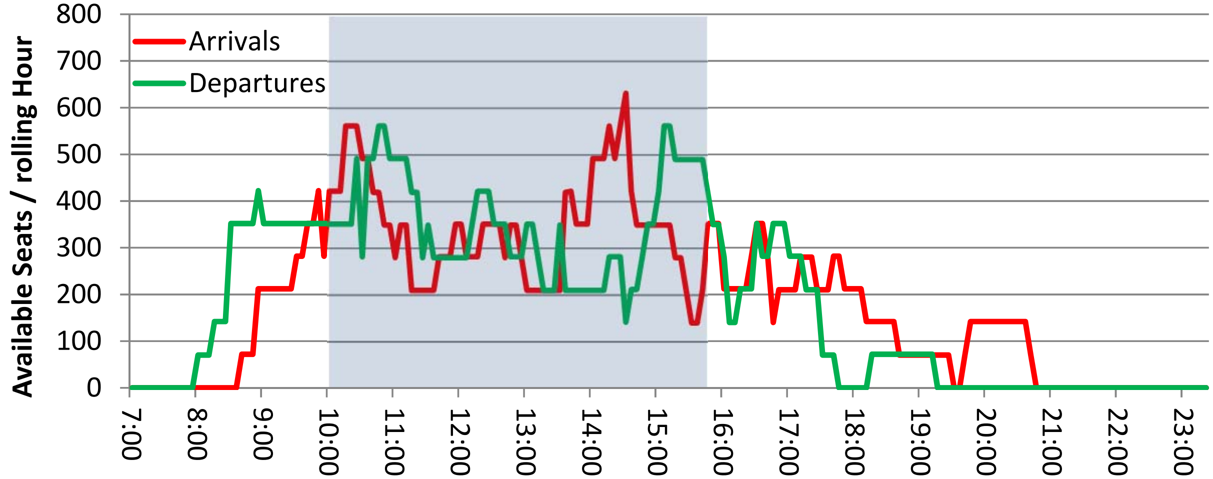

Fig 3.6 Daily Profile – Available Seats (Saturday, May 2013)

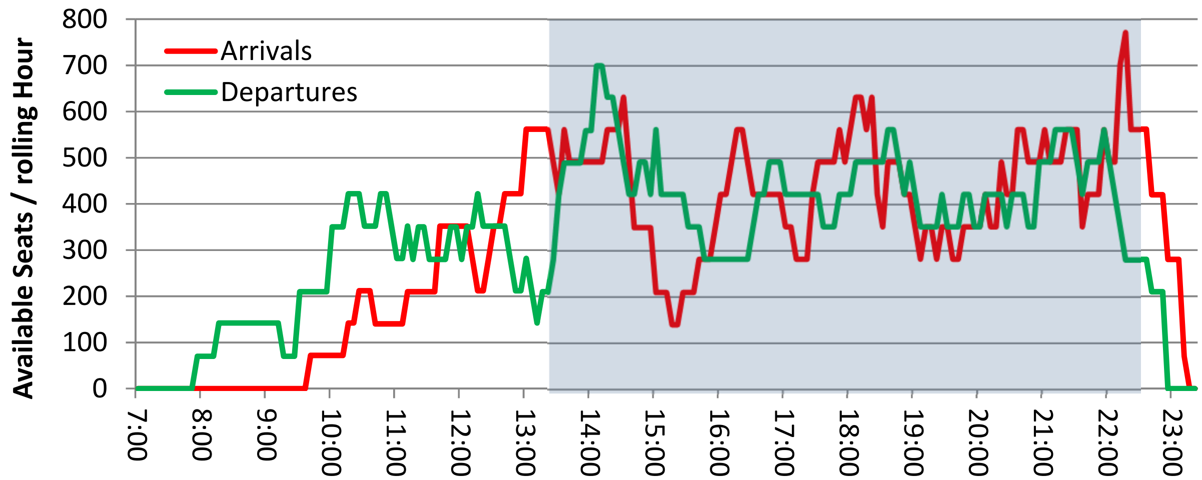

Fig 3.7 Daily Profile – Available Seats (Sunday, May 2013)[17]

[17] SABRE – May 2013 BBTCA Schedules

04. DESIGN AIRCRAFT

This section reviews the design aircraft proposed by Porter Airlines, the Bombardier CS100 (BD500-1A10) and its implications for infrastructure development and operational requirements at the Billy Bishop Toronto City Airport (BBTCA). The review focuses on the available literature on the performance of the aircraft and where applicable, provides support information expanding on what is already available in the public domain.[18] As well as aircraft currently in operation, proposed new aircraft entering service within the Canadian market in the coming years have been considered, such as the Mitsubishi Regional Jet, the A319neo, the B737max7 as well as the Embraer E-jet E2. Smaller existing jet aircraft such as Bombardier's CRJ and Embraer's ERJ were also subsequently reviewed.

On April 10 2013, Porter Airlines signed a conditional purchase order for 12 Bombardier CS100 aircraft, with options for an additional 18 CS100 aircraft[19]. The first CS100 aircraft was rolled out of the factory on March 7 2013 and its maiden test flight took place on 16 September 2013[20], following a delay to the initial projection of an end of June flight.[21]

DESIGN AIRCRAFT SPECIFICATIONS

As indicated by Bombardier, the CS100 is currently in development phase and as such is subject to changes notably in performance, design and/or systems. However as the testing and certification process evolves, revisions or new information are expected to be released by Bombardier that could impact the present review. The enhanced performance of the CS100 aircraft compared to aircraft currently operating is driven by a range of innovations relating to the design and materials utilized in the construction of the aircraft. However, the geared turbofan engine is the most significant driver with respect to the reduction in fuel consumption and noise levels.

The geared turbofan is not a new concept as it has been utilized on business jet applications since the

[18] http://media.bombardiercms.com/cseries/medias/cseries/galleries/cseries_download_high_en_2ad637.pdf
[19] Porter Airlines (May 2013)
[20] http://www.bombardier.com/en/media-centre/newsList/details.bombardier-aerospace20130916cseriesfirstflight.html
[21] Bombardier Aerospace (March 2013)

early 1970s.[22] It was more recently utilized on the 4-engined BAE146 aircraft which entered commercial service in 1983, later models of which (RJ-85, RJ-100) remain in use at London City and Bromma Airports. Both of these airports are characterised by short take-off length and stringent noise restrictions commonly associated with "inner city airports".

The documentation reviewed indicated a runway length requirement for the CS100 of up to 1,463m on take-off and 1,356m on landing based on operations at Maximum Weight, Sea Level (Toronto City Centre is at 77m above sea level) and 15° Celsius (based on International Standard Atmosphere (ISA) Conditions).[23] The expected range achievable under these conditions will generally vary as a trade-off between payload (e.g. passengers and their bags) and range. On warm days, runway length requirements will increase assuming all other variables remain equal. ICAO (International Civil Aviation Organization) "Doc 9157, Aerodrome Design Manual / Part 1:Runways" recommends an increase of the runway length of 1% for each 1° increase in temperature above ISA. Assuming a 30°C ambient temperature, runway length requirements could therefore increase by as much as 15% based on this indicative guideline.

The 1,569m take-off runway length and 1,399m landing distance requirement initially identified by Porter Airlines through Bombardier's advice would allow the CS100 to undertake unrestricted operations except under limited conditions where a combination of a high load factor, high temperature and long range destination is involved. Subsequently, a second proposal was presented with a revised take-off runway length requirement of 1,632m but a shorter landing distance available (LDA) of 1,371m. More recently, the TPA submitted to Transport Canada an additional iteration of Proposal #2 which further increased the take-off run available (TORA) to 1,656m without any change to the infrastructure.

It should be noted that the Dash8-Q400 requires a runway length similar to the CS100 at Maximum Take-Off Weight (MTOW). However, the difference lies in the ability of the Dash8-Q400 to operate with restricted runway length under limited payload penalties due to the short range of typical missions (500 nautical miles) which do not require full fuel uplift.

In regardto noise levels, the CS100 is planned to weigh 59 tonnes. Under Chapter 3 certification requirements for this aircraft weight, the cumulative exposure noise level of the three measurements points is 286 EPNDB[24]. Chapter 4 certification requires a cumulative noise level 10 dB below Chapter 3

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[22] http://theflyingengineer.com/flightdeck/pw1100g-gtf/

[23] http://media.bombardiercms.com/cseries/medias/cseries/galleries/cseries_download_high_en_2ad637.pdf

[24] See Chapter 7 for additional considerations to noise and definition of EPNDB metric.

resulting in 276 EPNDB. Bombardier is advertising the CS100 as being able to achieve 21 dB below Chapter 4, which would result in 255 EPNDB, similar to the Dash8-Q400 certification levels. In consultation with Porter Airlines, Bombardier has guaranteed that they would meet or better the Tripartite Agreement cumulative level of 259.5 EPNDB.[25]

CS100 AIRCRAFT NOISE TESTING

Although the CS100 noise certification flight tests will not take place until 2014, two sets of test data provide preliminary guidance on the likely outcomes. Certification is conducted by an independent third party and as such preliminary results have been accepted as provided from the manufacturers for the purposes of this review:

- Pratt & Whitney static engine test measurements; and
- Bombardier measurements of noise from CS100 Flight Test Vehicle 1 (FTV 1).

STATIC ENGINE TEST

Information on Static engine data collection methodology was conducted by Pratt and Whitney and sourced via Bombardier Aerospace.

Static engine noise testing using a fully equipped PW1500G engine was conducted in September 2013 at the certified Pratt & Whitney static engine test facility in West Palm Beach, Florida. This test was conducted to certification requirements and methods in accordance with SAE ARP1846A (Measurement of Far Field Noise from Gas Turbine Engines during Static Operation), ICAO Annex 16 and the ICAO Environmental Technical Manual (ETM). The same site and test methods have been used previously for authority-witnessed certification engine noise testing.

The static engine noise test included the complete thrust range of the engine, from idle to full take-off power. The test data was projected to the noise certification conditions using take-off and landing trajectories provided by Bombardier. The PW projection process follows the ICAO ETM guidelines and accounts for the effects of the following:

- Jet flight effect;
- Doppler shift;
- Distance & Atmosphere;

[25] Porter Airlines

- Ground Reflection; and
- Analyzer Dynamics.

At this stage of the CSeries program, the Pratt & Whitney static engine test provides the best data to determine the CS100 noise levels. Engine noise is the only significant noise source for the Lateral point. However Pratt & Whitney included airframe noise in their Lateral and Flyover levels. Engine noise also dominates the noise signature of the Flyover point and contributes approximately half of the noise for Approach. For the determination of the Approach noise level, the Bombardier CS100 airframe noise spectrum was added to the Pratt and Whitney data. The Effective Perceived Noise Levels were then calculated as per the ICAO procedures.

Condition	Noise Level (EPNdB)
Lateral	85.3
Flyover	80.1
Approach	91.0

Table 4.1 CS100 Noise Levels from Pratt & Whitney Static Engine Test Data

Pratt & Whitney has validated their static-to-flight predictions with a large database of over 50 noise certification flight test measurements from previous programs.

These results are in compliance with the noise limits set in the Tripartite Agreement except for an excess of 1.8 EPNDB laterally, which is within the trade-off limits defined in ICAO Annex 16.

FLIGHT TEST

Information on Flight Test Vehicle 1 (FTV1) data collection methodology and results are sourced from Bombardier Aerospace.

Bombardier measured each of the Lateral, Flyover and Approach conditions in October 2013 at Mirabel using CS100 FTV1. The tests used authority-approved instrumentation and microphone calibration, directivity and windscreen adjustment methods. Temperature, relative humidity, atmospheric absorption and winds were within ICAO Annex 16 test limits.

All data was adjusted to the certification reference conditions using the procedures in ICAO Annex 16 and the ETM. As allowed in ICAO Annex 16, adjustments for differences between test and reference trajectory thrust levels were made using noise-thrust relationships provided by Pratt & Whitney.

Condition	Noise Level (EPNdB)
Lateral	85.2
Flyover	80.7
Approach	90.7

Table 4.2 CS100 Noise Levels from FTV1 Flight Test Data

These results are in compliance with the noise limits set in the Tripartite Agreement except for an excess of 1.7 EPNDB laterally, which is within the trade-off limits defined in ICAO Annex 16.

ENTRY-INTO-SERVICE CS100

Once an aircraft has entered into the flight test program, it is common for the manufacturer to continue development testing leading to an enhanced design prior to the certification test. This allows the manufacturer to identify opportunities to further reduce the noise levels. Bombardier has implemented the practice of performing an engineering noise test approximately 6 months prior to the certification test.

WAY FORWARD

The information disclosed at this stage of the testing process for the Bombardier CS100 is trending in line with previous information and statements made by the manufacturer. However, formal confirmation of the compliance of the CS100 to the Tripartite Agreement noise limits will only occur at the outcome of the Transport Canada certification process which is presently expected to occur in May 2014.

AIR QUALITY

In regard to air quality, a preliminary review of literature indicates that the CS100 will likely meet the most current international emissions standards (CAEP/6). Emissions from the operations of the CS100 should exceed that of the Dash8-Q400 because of the different engine used (jet engine vs turboprop) and the type of mission (transcontinental vs regional). A comprehensive review of emissions impact being beyond the scope of this study, additional data was provided to Golder & Associates to support their health impact study.

The following table outlines the key specifications of the CS100 and the Dash8-Q400 for comparative purposes.

Bombardier Dash8-Q400		Bombardier CS100
		
	Physical	
32.8 m	Length	35 m
28.4 m	Width	35.1 m
8.4 m	Height	11.5 m
74	Pax (Typical)	110
6,616 L	Fuel Capacity	~22,000 L
	Performance	
29,574 kg	Maximum Take-Off Weight (MTOW)	58,513 kg
3,410 kW (Power)	Engine Thrust	103.5 kN
2,063 km	Range (@MTOW)	2,778 km
1,468 m	Runway Length (ISA, MTOW, SL)	1,463 m
	Noise / Environment	
84.0	Takeoff (EPNdB)	Tbd
93.1	Approach (EPNdB)	Tbd
78.6	Flyover (EPNdB)	Tbd
255.7	Cumulative (EPNdB)	is less than 259.5 (Bombardier)
21.2 g/kN	Nox Emissions	56-58% margin
5.6 g/kN	UHC Emissions	85% margin
86 g/kN	CO Emissions	80% margin

Table 4.3 CS100/Q400 Aircraft Comparative Table

COMPARABLE AIRCRAFT

The proposal by Porter Airlines is based on performance data specific to the Bombardier CS100. However, the resulting facilities may be suitable to a wider group of aircraft types. This section assesses comparable existing aircraft types as well as aircraft projected to enter service before the end of the decade using the same engine technology (geared turbofan) as the Bombardier CS100 or similar technology.

MITSUBISHI MRJ70/90

Mitsubishi Aircraft Corporation was scheduled by the end of 2013 to be the next manufacturer to roll-out a jet with the Pratt & Whitney geared turbofan technology but this has now been revised to the first half of 2015 with deliveries due to be starting in 2017[26]. Two US-based regional carriers (Trans State Holdings and Skywest) have already purchased the MRJ which would end up operating as part of the regional networks of United, Delta or American/US Airways. The current combined order is for 150 MRJ90 with an option for an additional 150 aircraft.

Like the CS100, the MRJ90 has yet to complete the certification process and therefore its performance specifications are subject to confirmation. However, based on the available information, the MRJ70 (approximately 78 seats) and MRJ90 (approximately 92 seats) would be able to operate at BBTCA with some trade-off in range based on payload level and the exact model operated. As the MRJ70 and MRJ90 are using a smaller Pratt & Whitney geared turbofan, when compared to the CS100, the noise levels for the MRJ may be as low as or lower than the CS100. No Canadian carriers have purchased the MRJ to date.

EMBRAER 170/190

Embraer has dominated the market for aircraft in the 70-110 seats range in recent years. This aircraft family has been in production since 2002 and it was recently announced that a new re-engined version using the same geared turbofan technology as the C Series would enter service before the end of the decade.[27] A high-level review of the performance of the E170/E190 family indicates a probable ability to

[26] http://www.flightglobal.com/news/articles/mrj-first-flight-delayed-to-q2-2015-389760/
[27] http://www.embraer.com.br/en-US/ImprensaEventos/Press-releases/noticias/Pages/Embraer-lanca-E2-a-segunda-geracao-de-EJets.aspx

operate from BBTCA generally with a reduced payload under most environmental conditions. Although the current models operating do not meet the noise limits established under the Tripartite Agreement, the re-engined version of the EMB170/190 series should have the ability to be certified at noise levels below those set in the Tripartite Agreement by the time it enters service in or around 2018. The Embraer 175 and 190 is operated by Air Canada as well as a range of Transborder carriers.

BOEING 737-600/700/800/900

The Boeing 737NG (Next Generation) series is the most recent upgrade of this aircraft family which was first delivered in 1997 and has since sold almost 5,000 aircraft. With seating capacity ranging from 108 (-600 model) to over 200 seats (-900 model), the ability of this aircraft to operate at the BBTCA will vary broadly based on the model, engine application, payload and destination.

The Next Generation series does not meet the noise levels established within the Tripartite Agreement, but the proposed re-engined model (Boeing 737max) using the LEAP direct drive turbofan technology may be able to meet these standards once it enters service in approximately 2017. Boeing is not currently planning a B737max-6 with the B737max-7 scheduled to be the smallest model in the series and will have a similar seating capacity as existing B737-700 (e.g. 136 seats for WestJet).[28]

The Boeing 737 is notably operated in Canada by WestJet, as well as by leisure carriers Sunwing, Air Transat (2014 onwards) and CanJet, as well as by several Transborder carriers. Over 1,300 B737max have been ordered, including 65 (25 max7 and 40 max8) by WestJet on 26 September 2013.[29]

AIRBUS A318/319/320/321

The Airbus A320 family series covers seating capacity ranging from 107 (318 model) to over 200 seats (321 model) with over 5,000 aircraft delivered since its entry into service in 1988.[30]

The current models in the Airbus A320 family do not meet the noise levels established within the Tripartite Agreement. However, the A319neo (new engine option) using the geared turbofan (or LEAP engine) technology will provide significant performance enhancements, which may allow this aircraft to comply with the Tripartite Agreement requirements upon certification. However, based on an advertised 15 dB below Chapter 4, this would result in the combined sum of all three (3) measurement

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[28] http://www.newairplane.com/737max/design-highlights/#/characteristics/
[29] http://business.financialpost.com/2013/08/29/westjet-airlines-ltd-pens-deal-to-buy-65-of-boeings-new-737-max-planes/
[30] http://www.airbus.com/aircraftfamilies/passengeraircraft/a320family/a320/

points as being 265 dB, which remains 5 to 6 dB above the current requirements set in the Tripartite Agreement.[31]

Airbus is not currently planning an A318neo with the A319neo scheduled to be the smallest model in the series.[32] The A320 series is notably operated in Canada by Air Canada, Air Canada Rouge as well as by several Transborder carriers. Over 2,000 aircraft of the A320neo family have been ordered to date, although none by Canadian carriers at this time. Several American carriers have purchased the A319neo, A320neo and A321neo.[33]

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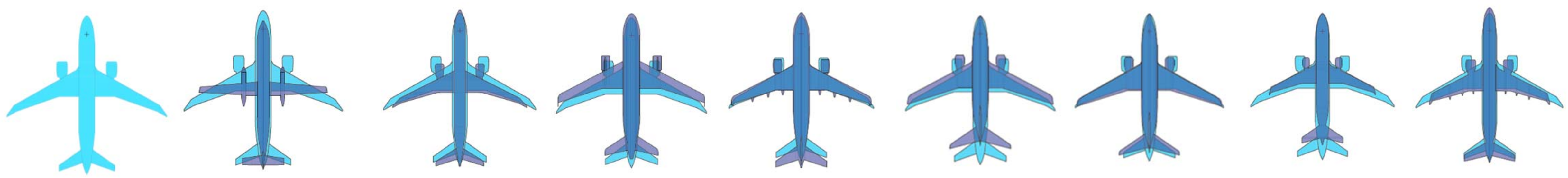
[31] http://www.pw.utc.com/Content/Press_Kits/pdf/ce_pw1100g_pCard.pdf
[32] http://www.flightglobal.com/news/articles/airbus-could-eventually-offer-neo-version-of-a318-leahy-350386/
[33] http://www.airbus.com/presscentre/corporate-information/orders-deliveries/

SUMMARY

The following table summarizes key specifications of aircraft currently in operation or scheduled to operate in the foreseeable horizon that are most closely comparable to the CS100. Data relating to performance and noise may vary based on exact configuration of each aircraft.



		Aircraft								
		Bombardier		Mitsubishi	Airbus		Boeing		Embraer	
		CS100	**Dash8-Q400**	**MRJ90**	**A318**	**A319**	**B737-600**	**B737-700**	**E175**	**E190**
Entry in Service		**2014**	**In Service**	**2017**	**In Service**	**In Service**	**In Service**	**In Service**	**In Service**	**In Service**
Physical										
Length	m	35	32.8	35.8	31.44	33.84	31.2	33.6	31.68	36.24
Width	m	35.1	28.4	29.2	34.1	34.1	34.3	35.8	26	28.72
Height	m	11.5	8.4	10.5	12.56	11.76	12.6	12.5	9.73	12.08
Pax (Typical)	#	110	74	92	107	124	110	126	78	98
Performance										
Maximum Take-Off Weight (MTOW)	kg	58,513	29,574	39,600	68,000	75,500	66,000	70,080	37,500	47,790
Engine Thrust	kN	103.5	3,410 kW (Power)	78	106	120	101	117	61	82
Range (@MTOW)	km	2,778	2,063	1,670	5950	6,850	5,970	6,370	3,704	4445
Runway Length (ISA, MTOW, SL)	m	1,463	1,468	1,490	~1,800	~2,150	~1,800	~1,600	2,244	2,056
Noise										
Takeoff	EPNdB	-	84.0	-	94.9	93.8	90.7	95.4	84.4	91.8
Approach	EPNdB	-	93.1	-	92.4	94.6	95.6	95.8	91.9	92.4
Flyover	EPNdB	-	78.6	-	84.1	84.5	81.3	81.4	95	86.3
Cumulative	EPNdB	<259.5	255.7	-	271.4	272.9	267.6	272.6	271.3	270.5

Table 4.4 CS100 Comparable Aircraft Summary Table

SMALL COMMERCIAL JET REVIEW

In addition to jet aircraft with a capacity of over 75 passengers, a range of existing jet aircraft with seating capacity ranging from 37 to 50 seats may also be able to operate at BBTCA, most likely only once the runway is extended to enable commercial operations.
The main manufacturers in this market, Bombardier's CRJ and Embraer's ERJ, have been reviewed.

BOMBARDIER REGIONAL JET (CRJ-100/200/700/900/1000)

The Bombardier Regional Jet (previously known as Canadair Regional Jet) was launched in 1992 to fill a gap in the regional market and in thin medium-range markets.[34] There was also a perceived lack of confidence in turboprop aircraft compared with jet aircraft that initially fuelled the success of this aircraft despite its higher operational cost.
The original CRJ (50 seats) was launched in 1992. Stretched versions followed in 2001 offering up to 100 seat capacity for the CRJ-1000. The CRJ200 was found to be in compliance with the certification noise levels set in the Tripartite Agreement.[35]

EMBRAER REGIONAL JET (ERJ-135/140/145)

The Embraer Regional Jet was launched in response to the Bombardier CRJ. The ERJ-145 was brought into service in 1996, with shorter versions introduced in 1999 (ERJ-135) and 2001 (ERJ-140).[36] It was initially designed from the Embraer Brasilia, a twin turboprop aircraft with which a lot of commonality in parts was maintained despite the change in power plant.
Over 1,100 aircraft have been sold and although not used by Canadian carriers, this aircraft is popular with several US commuter carriers. All ERJs (37 to 50 seats) were found to be in compliance with the noise levels set in the Tripartite Agreement.[37]

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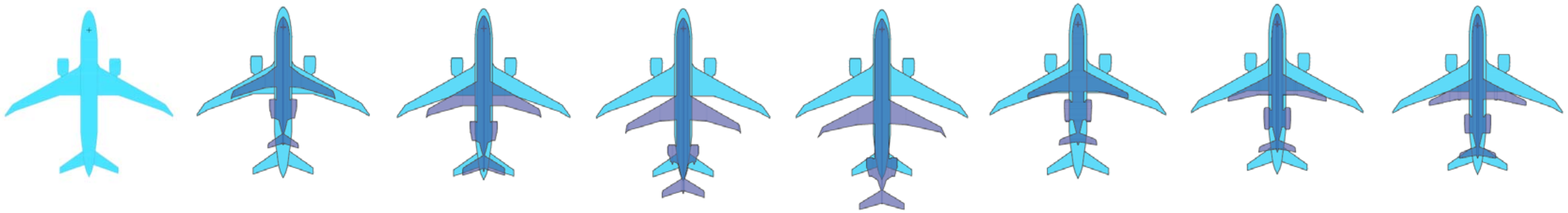
[34] Air Insight(April 2011)
[35] ICAO Noise Database
[36] Air Insight(April 2011)
[37] ICAO Noise Database

SUMMARY

The following table highlights key specifications of these aircraft including compliance to the Tripartite Agreement noise limits. Data relating to performance and noise may vary based on exact configuration of each aircraft.



		Aircraft							
				Bombardier				**Embraer**	
		CS100	**CRJ100/200**	**CRJ700**	**CRJ900**	**CRJ1000**	**ERJ135**	**ERJ140**	**ERJ145**
Entry in Service		**2014**	In Service	In Service	In Service	In Service	In Service	In Service	In Service
Physical									
Length	m	35	26.77	32.51	36.37	39.10	26.33	28.45	29.87
Width	m	35.1	21.21	23.24	23.24	26.20	20.04	20.04	20.04
Height	m	11.5	6.22	7.57	7.51	7.10	6.75	6.75	6.75
Pax (Typical)	#	110	50	70	90	104	37	44	50
Performance									
Maximum Take-Off Weight (MTOW)	kg	58,513	21,523	32,999	36,514	41,640	20,000	20,600	22,000
Engine Thrust	kN	103.5	61	56	60	61	33	33	33
Range (@MTOW)	km	2,778	2,417	2,656	2,500	2,491	2,400	3,057	2,873
Runway Length (ISA, MTOW, SL)	m	1,463	1,530	1,607	1,780	1,944	1,700	1,380	1,400
Noise									
Takeoff	EPNdB	-	82.4	89.6	89.3	89.4	84.3	84.3	85.3
Approach	EPNdB	-	92.2	92.6	92.8	93.3	92.3	92.4	92.4
Flyover	EPNdB	-	77.0	82.0	83.4	85.3	79.0	80.0	80.0
Cumulative	EPNdB	<259.5	251.6	264.2	265.5	268.0	255.6	256.7	257.7
Tripartite Agreement Compliant*		tbd	**Yes**	No	No	No	**Yes**	**Yes**	**Yes**

Table 4.5 Small Commercial Jet Summary Table

TURBOPROP AIRCRAFT FLEET DEVELOPMENT

The focus of the Porter Airlines proposal is on the introduction of jet aircraft at BBTCA. However, it is also important to note foreseeable developments in turboprop aircraft technology over the coming years.

When the modern regional jet entered the market in the 1990s with the Bombardier CRJ, followed by the Embraer ERJ, it was believed that this would adversely affect the turboprop aircraft market. However, increasing fuel costs and improvements to the best-selling turboprop aircraft (Bombardier's Dash8-Q400 and ATR's 72-600) have led to a renewed interest for this aircraft type, especially on short sectors of up to 500nm (approximately 1,000 km). In this category the turboprop offers a similar gate to gate operating time at a lower cost compared to regional jets.

The regional jet market is now focussed on aircraft operating on longer sectors where turboprop aircraft are not competitive or physically able to achieve the performance sought with seat configurations ranging from 70 to over 100 seats.

With the turboprop aircraft serving increasingly larger markets over short sectors, ATR and Bombardier have been considering a stretched version of their respective turboprop aircraft which would take them up to 90 seats. Although Bombardier is currently dismissing any plans, ATR remains open to the idea and is considering a brand new aircraft as opposed to a stretched version of the ATR72.[38]

Hence, although a larger turboprop is unlikely to be entering service in the foreseeable future, such an aircraft would likely be able to operate from BBTCA. Some incremental improvements to airport infrastructure may be required, especially to cater for an increase of over 25% in seats.

[38] http://atwonline.com/blog/where-things-stand-90-seat-turboprop

05. CAPACITY ASSESSMENT

This section assesses the "ultimate" capacity of the airport based on existing operational conditions and in accordance with the Tripartite Agreement. It is followed by a scenario-based review of the incremental capacity effect that would be associated with the lifting of restrictions on jet aircraft operations.

FREQUENCY MANAGEMENT / SLOT CAP

A key determinant of the airport's capacity is the slot cap on scheduled movements. The slot cap is in place in order to ensure the overall airport's compliance to the terms of the Tripartite Agreement, which states that the TPA must "regulate the overall frequency of aircraft movements in order to contain the actual 28 NEF Contour within the boundary of the official 25 NEF Contour for 1990." There are two exceptions to this statement and they are indicated between the two points marked X and Y as shown on Figure 7.10 of this report.[39]

The *Billy Bishop Toronto City Airport Capacity Report (February 2010)* assessed a range of operational scenarios before retaining a slot count of 202 daily commercial movements which are based on the following considerations:

- Restricted night movements (6:45-7:00 and 22:00-23:00) for existing commercial movements (7 movements) as well as some General Aviation Movements between 22:00 and 23:00;
- 90% of commercial movements operated by Dash8-Q400 (or Q300) with remaining 10% assumed to be Dash8-100/200 (or equivalent); and
- Provisions for a range of general aviation activities including helicopter movements that can operate in addition to the commercial movements cap.

A slot coordinator was appointed to manage the slot allocation process following the increase in the slot cap from 120 to 202 movements. As of 2013, the slots are distributed as follows:

- Porter Airlines: 172 slots (including grandfathered rights on night movements); and
- Air Canada: 30 slots (no night movements).

[39] See Chapter 7 for additional considerations to noise

Since the Tripartite Agreement itself does not specify the actual maximum number of slots, the cap on movements could conceivably be changed over time based on changing operational conditions, the fleet mix in operation and the noise modelling tool and assumptions used by Transport Canada, while still complying with the Tripartite Agreement.

For the purposes of this study, a base assumption, agreed to with the City of Toronto staff, is that the 202 slot cap will remain as a known constraint based on advice from the Toronto Port Authority that it does not anticipate changes to the existing slot cap. Future studies may undertake additional noise modelling as more information becomes available on the noise levels of the CS100 and other new aircraft, and once Transport Canada determines the appropriate parameters for modelling this aircraft. The proposed runway extension would also impact the extent of noise contours since aircraft would operate further into the harbour. However, this work is beyond the scope and timing of this review.

AIRSIDE CAPACITY

The determination of an airport's capacity is based on a range of considerations from airside to landside. The proposed extension of Runway 08-26 will not increase aircraft movement capacity, but provides the opportunity for larger jet aircraft to operate.

The following chart highlights recent peak busy hour movements for the BBTCA as recorded by Transport Canada. It includes operations on all runways by all aircraft types (including commercial) but differentiates itinerant movements (to/from another airport) from local movements (to/from BBTCA).

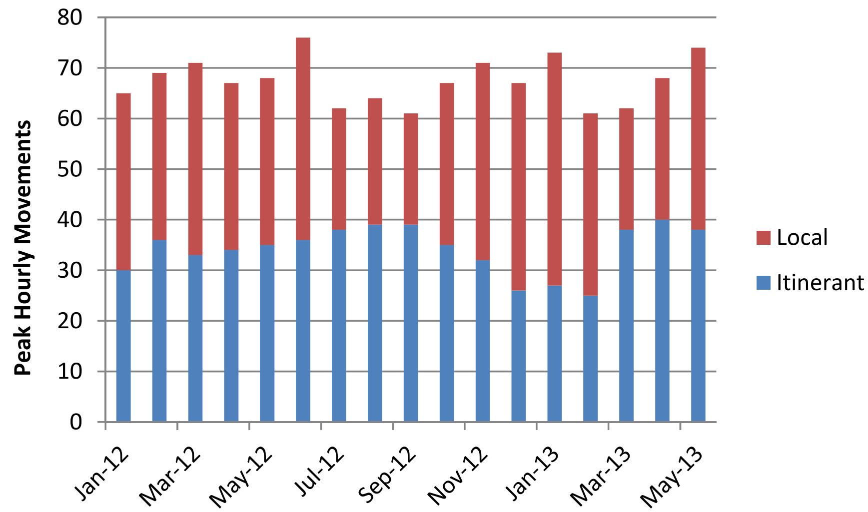


Fig 5.1 Peak Hour Movements by Month[40]

Furthermore, because the configuration of the proposed runway extension is not currently associated with a parallel taxiway to the new runway end, aircraft requiring the full length of Runway 08-26 on take-off would effectively need to backtrack on the runway to the runway end. This would be exacerbated for departures off Runway 26 since Taxiway Delta will not be accessible when Runway 08-26 gets reclassified as Code 3. This would reduce the hourly capacity of the runway to an extent that will be dependent on the timing of operations requiring the full runway length. Detailed runway capacity and review of the impact of the proposed airfield has not been undertaken as part of this study.
The 2012 actual total annual origin/destination demand was over 2.3 million passengers[41] including approximately 400,000 transfer passengers. This results in groundside demand of about 1.9 million passengers annually (passengers that depart or arrive at the BBTCA).[42] The cap of 202 commercial movements creates an artificial demand limit on the facilities. All slots are currently operated by Dash8-

[40] Transport Canada
[41] http://www.bloomberg.com/article/2013-08-23/a4g8spQK0ypc.html
[42] http://www.torontoport.com/About-TPA/Media-Room/Press-Releases/TPA-2012-Year-End-Results.aspx

Q400 with 70 seats[43]. However, although weekday slots are generally well utilized, schedules for Porter Airlines and Air Canada indicate that the slots are used at about 50% of their maximum levels on Saturdays, and at about 75% of the maximum levels on Sundays.

Under the present scenario (202 daily commercial movements), assuming a planning load factor of 85% for all operations, an estimate of the annual airport capacity is approximately 3.8 million passengers. Of those passengers, it is assumed that 25% would be transferring from an arrival flight to a departing flight, which results in about 1 million annual transferring passengers and about 2.8 million annual passengers who would interface with groundside facilities at BBTCA. The transfer ratio assumed is an average and may vary across the year, months and days.

A key consideration when assessing facility requirements is the busy hour capacity. The use of larger aircraft with more seating capacity will increase busy hour passenger movement demand which will in turn require increased capacity of terminal and groundside facilities.

Using similar assumptions as the current annual capacity, namely a load factor of 85%, and assuming that all gates are used 1 or 2 times during a given hour, the hourly capacity is estimated at approximately 870 passengers per hour based on the current layout of 10 aircraft gates. Taking into account an average transfer rate of 25%, the demand on groundside would be approximately 650 passengers per hour, each way. Under a scenario where all seats are filled during a busy hour, demand could grow up to approximately 765 passengers per hour, each way.

When specifically considering the introduction of the CS100 (107 seats), assuming the same slot count and overall utilization, this leads to an incremental annual increase in capacity. The current operational model of the Dash8-Q400 involves short-haul flights (under 500 nm) with quick turnarounds which allows for up to 12 turns[44] a day per aircraft. The CS100 would primarily be used on medium-haul routes, but it would provide Porter Airlines the ability to modulate its capacity during busy hours on short-haul business sectors, if required, and to connect transferring traffic to onward medium-haul destinations (e.g. West Coast, Florida, Caribbean) throughout the day. Overall, this would lead to the operations of fewer sectors across the day with an estimate of 3 turns per day per aircraft (as estimated by Porter Airlines). A conservative scenario of 25% of all slots utilized by the CS100 aircraft was developed. When retaining the assumption of an 85% load factor, the annual passenger movement capacity of the airport becomes approximately 4.3 million passengers, an increase of 500,000

[43] WestJet operates a 78-seat version, Air Canada Jazz operates a 74-seat version.
[44] A turn is defined as the transition between an arrival and a departure.

passengers or approximately 14% over existing capacity which corresponds to a low growth scenario per the assumptions used in the HLT Advisory Report[45]. Assuming that the introduction of the CS100 would lead to an increased utilization of available slots during the weekend, the annual capacity of the airport could grow to 4.6 million and 4.8 million passengers under a medium and high growth scenario respectively per HLT Advisory assumptions.

During the busy periods, the ability to park up to 4 CS100s concurrently could increase capacity to approximately 1,240 passengers per hour in each direction (910 passengers O/D[46]), an increase of approximately 50%. The following table provides a summary of the key findings of this high level scenario based assessment.

	Dash8-Q400 only	Dash8-Q400 (75%) / CS100 (25%)
Slot Distribution Scenario	100% - Dash8-Q400	75% - Dash8-Q400 25% - CS100
Load Factor Scenario	85%	85%
Transfer Rate Scenario	25%	25%
Annual Passenger Movements Capacity	3.8 million – Total 2.8 million – O/D 1.0 million - Transfer	4.3 million – Total 3.2 million – O/D 1.1 million - Transfer
Hourly Passenger Movements Capacity	870 Pax – Total (Each Way) 650 Pax – O/D (Each Way) 220 Pax – Transfer (Each Way)	1,240 Pax – Total (Each Way) 910 Pax – O/D (Each Way) 330 Pax – Transfer (Each Way)

Table 5.1 Airside Capacity – Summary Table

TERMINAL CAPACITY

In order to process the passenger capacity defined by the airside and apron parking plans, the passenger terminal must provide adequate processing and holding facilities for each step in the passenger journey. A previous study, completed by Airbiz in 2010, found that the existing passenger terminal has approximately a 720 passenger per hour capacity for origin/destination activity, which is sufficient to

[45] Economic Impact Considerations of an Expanded Billy Bishop Toronto City Airport
[46] Passengers for who Toronto City Centre is the point of departure or arrival.

process the maximum hourly capacity induced by airside facilities and the existing fleet mix of Q400 aircraft.

Under a scenario where the CS100 operates during the busy hour, there would be a need to upgrade terminal facilities to enhance the total processing rate of key facilities. The specific needs of each processor were not reviewed within this study. However, the areas of anticipated expansion would include:

- Check-In;
- Security screening;
- Outbound and Inbound Baggage Systems;
- Hold Rooms;
- US Customs and Border Protection (USCBP) Facilities (no current facilities); and
- Canadian Border Services Agency (CBSA) Facilities.

Consultations with Porter Airlines have confirmed that they have considered some of these facility enhancements at a very high level, but that their planning is in the early stages as they have tied the expansion requirements to the approval of the proposal to allow the CS100 to operate at BBTCA. The ability to expand existing passenger terminal facilities to the north and south in incremental phases appears to have a nominal impact on the adjacent areas. Further expansion capacity also appears to exist within the current footprint of the terminal building.

GROUNDSIDE CAPACITY

Excluding any considerations of the road access system and parking facilities which was not considered as part of this review, the key bottleneck of airport capacity on groundside currently is the ferry service. Previous studies found that about 800 passengers could be processed across the channel every hour which was sufficient to meet the demand under a scenario where the Dash8-Q400 was the only commercial aircraft operating. As previously reported, the main benefit of the upcoming pedestrian tunnel is the ability to allow a steady-flow of passengers to/from the passenger terminal building or the curb on groundside. This contrasts with the present situation of four distinct arrival waves creating a sudden stress on processing facilities, which leads to increased wait times and reductions in the level of service provided by the carriers.

Under a scenario where the CS100 is introduced into commercial operation, the busy hour demand would have exceeded the capacity of the ferry terminal without the use of the pedestrian tunnel. Under this scenario, the pedestrian tunnel becomes essential in eliminating the ferry service capacity constraint.

The pedestrian tunnel will consist of six elevators on the mainland side and three banks of escalators and two elevators on the island side.[47] The TPA has advised that the capacity of the pedestrian tunnel is 1,066 passengers per hour each way.

[47] Meeting Minutes 29 May 2012 – Construction Period Liaison Committee – Forum Equity Partners

06. INFRASTRUCTURE REQUIREMENTS

This section reviews the infrastructure requirements associated with the Porter Airlines proposal. Whilst the lengthening of Runway 08-26 is the key aspect of the proposal, the review considers associated impacts from airside to groundside, including the passenger terminal building.
The review uses industry literature, material provided by Porter Airlines and high-level consultations with Transport Canada as a basis of study. They were initially unable to comment on the particular details of the proposal by Porter Airlines as they had not received a formal request from the airport operator. Since then, it is understood that Transport Canada has received a formal request from the Toronto Port Authority to consider a proposal by Porter Airlines. Proposal #2 (200m extension into the water at each end) was submitted but outcomes of this process have not yet been shared with the City of Toronto. Any input from Transport Canada included in this report, is therefore of a generic nature and has been used to guide the interpretation of the current aerodrome standards and recommended practices (TP312E). Any exemptions or possible exemptions that may be considered with respect to the BBTCA and/or the Porter Airlines proposal may have been addressed by Transport Canada but have not been disclosed to the City. Therefore, this report is based on the proposals that have been put forward by Porter Airlines and may be modified or refined as a result of consultations with Transport Canada.

RUNWAY LENGTH REQUIREMENTS

The runway length required to enable commercial operations varies significantly based on a range of factors. A key determinant is the selection of the critical design aircraft, which for this proposal is the Bombardier CS100. Other key operational and environmental factors include:

- Destination (i.e. range);
- Payload (i.e. passengers, bags and fuel); and
- Temperature and wind conditions.

Because of the variability of payloads and environmental conditions, it is complex and costly to plan for all potential operational occurrences of various aircraft types. Airlines will generally accept operational limitations for infrequent constraints rather than pay on a cost recovery basis for additional capital and operations expenditure to accommodate all contingencies. The preliminary information available for the Bombardier CS100 confirms the ability of this aircraft to operate within the parameters of the proposed runway extension under standard conditions and subject to the final declared distances. Chapter 11 of this report describes in more details the indicative declared distances of each proposal compared to the status quo.

WIND ANALYSIS AND RUNWAY USABILITY

The ability of an aircraft to use a runway can be affected by prevailing wind conditions. Under ideal conditions, aircraft operators will seek to land into the wind (i.e. head wind) with a crosswind component (i.e. wind blowing sideways) that is within the tolerance of the aircraft. Generally, larger aircraft have a greater tolerance to crosswind. The CS100 and Dash8-Q400 have a crosswind tolerance in excess of 20 knots depending on conditions. Based on a review of prevailing winds for 2012 at the BBTCA, it was found that aircraft can operate off the main Runway 08-26 for 99.77% of the time within a 20 knot crosswind component, well in excess of the recommended value of 95% set by international standards. Considering a more conservative scenario, a crosswind tolerance of 13 knots was applied in line with ICAO's guidelines for aircraft with aerodrome reference field length between 1,200m and 1,500m. In this case, a runway usability factor of 95.63% is achieved, still above the recommended threshold of 95%.[48] This indicates that there is no need for a second runway at the BBTCA for commercial aircraft due to wind coverage. However, smaller general aviation aircraft will benefit from the additional runways at the BBTCA as their crosswind tolerance will generally be lower thus requiring more operational options.

Based on a low 10 knot crosswind tolerance, a single Runway 08-26 would provide a 89.24% usability, below the recommended 95% threshold. By including Runway 15-33, the usability is increased to 96.84%, while adding Runway 06-24 to the assessment indicates a total usability of 98.85%.

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[48] ICAO Annex 14 – Aerodromes - Volume I, Aerodrome Design and Operations

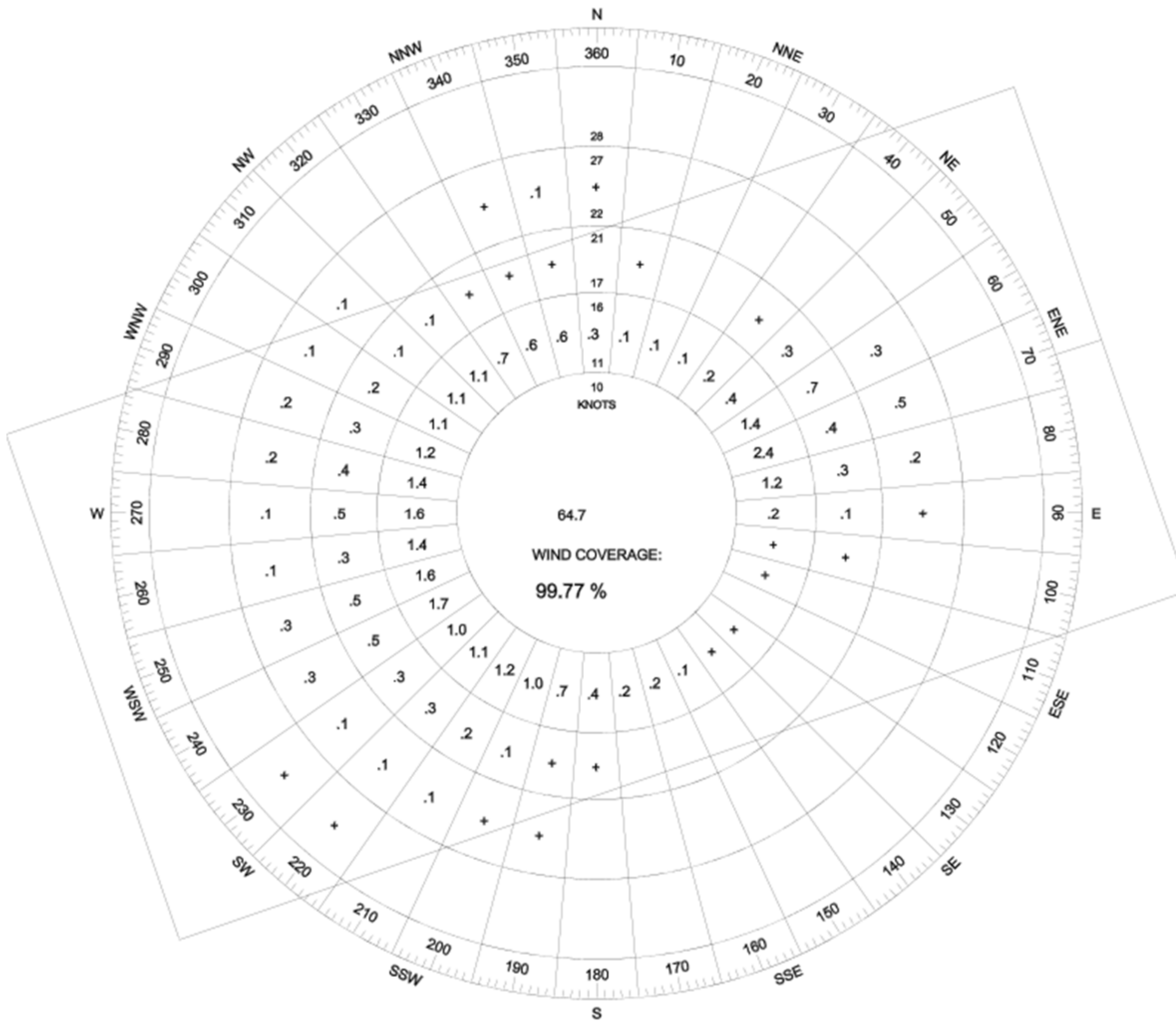

Fig 6.1 Runway 08-26 Wind Coverage – 20 knots crosswind tolerance[49]

[49] Environment Canada / FAA WindRose

OBSTACLE LIMITATION SURFACES

Obstacles Limitation Surfaces (OLS) define the limits to which objects may project into the airspace. This is done to allow the aerodrome to operate safely and to minimize the dangers presented by obstacles to an aircraft. Obstacles are typically surveyed periodically to ensure the OLS is not penetrated as this can impact an aircraft either during an entirely visual approach or during the visual segment of an instrument approach. The OLS surfaces also prevent the aerodrome from being restricted by the growth of potential obstacles in and around the aerodrome.

These surfaces are protected at BBTCA for Runway 08-26, the main east-west runway and the only one on which Dash8-Q400 and CS100 can operate at BBTCA, by the enactment of Airport Zoning Regulations (AZR) SOR/85-515 in accordance with the Aeronautics Act.[50] It prohibits the erection of any new structure which would penetrate any of the defined surfaces. Under these regulations, the runway, runway strip, approach surfaces, transitional surfaces and outer surface are defined. For BBTCA, despite currently operating Runway 08-26 under Code 2 classification, the AZRs are based on a Code 3 non-precision classification for the runway strip and associated transitional surfaces. However, the approach surfaces are based on a more stringent requirement for Runway 08 (2% compared to 2.5% Code 3 non-precision requirement) and a less stringent requirement for Runway 26 (5% compared to 2.5% Code 3 non-precision requirement). Although Transport Canada did not specifically comment on this proposal, they advised that “the current AZRs will not protect for a longer runway. If protection is required for a longer runway, the AZR would have to be amended.”

Furthermore, BBTCA currently operates with exemptions from Transport Canada with regard to the OLS approach surfaces. For Runway 08, the exemption allows the approach surface at 4.8% while for Runway 26, the exemption allows the approach surface at 6.38%.[51] Transport Canada has not discussed the implications of a change to Code 3 operations on these existing exemptions.

The proposed layout as set-out in the Porter Airlines proposal retains the approach surfaces at their existing locations which would ensure the integrity of the Marine Exclusion Zone (MEZ) subject to approach exemptions being confirmed by Transport Canada. For take-off operations, declared distances (e.g. TORA, TODA) would need to be confirmed with Transport Canada to ensure that appropriate clearances from obstacles are also provided, more specifically in regard to harbour operations. It is

[50] http://laws-lois.justice.gc.ca/eng/regulations/SOR-85-515/
[51] Porter Airlines Runway 08-26 Extension Study Billy Bishop Toronto City Centre Airport, May 24, 2013

understood that a proposal was submitted to Transport Canada by the TPA and is currently being reviewed.

RUNWAY-END SAFETY AREAS (RESA)

Runway-End Safety Areas (RESA) are defined by ICAO as “an area symmetrical about the extended runway centre line and adjacent to the end of the strip primarily intended to reduce the risk of damage to an aeroplane undershooting or overrunning the runway”.[52] Since 1999, what previously was a recommendation of a 90m runway-end safety area beyond the runway strip became a requirement from ICAO. An additional recommended practice was then introduced for a 240m length RESA for Code 3 and 4 runways (those which are 1,200m or longer).[53] The runway end safety areas are required to have a minimum width twice the associated runway, extend away from the runway, be centred on the extended runway centreline and have a minimum length of 150 m to the end of the RESA (except under special circumstances). Since the Canadian Aerodromes Standards and Recommended Practices (TP312E) were last updated in 1993, the provisions of Runway-End Safety Areas remain a recommendation within the Canadian context.

Following the overrun of an Airbus A340 at Toronto-Pearson International Airport on 2 August 2005, the Transportation Safety Board (TSB) issued the following recommendation to Transport Canada in December 2007: “the Department of Transport require all Code 4 runways to have a 300 m runway-end safety area (RESA) or a means of stopping aircraft that provides an equivalent level of safety.” The TSB subsequently added the issue of landing accidents and runway overruns to its inaugural watchlist of the transportation safety issues posing the greatest threat to Canadians with RESA identified as a key mitigating measure.[54]

The following chart highlights the key features of Runway-End Safety Areas based on the ICAO minimum requirement standards as applied to Runway 08 at BBTCA.

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[52] TP 312 - Aerodromes Standards and Recommended Practices, Transport Canada, March 2005

[53] Annex 14 to the Convention on International Civil Aviation: Aerodromes Volume 1, Aerodrome Design and Operations ICAO, Fifth Edition, July 2009

[54] http://www.bst-tsb.gc.ca/eng/recommandations-recommendations/aviation/2007/rec_a0706.asp

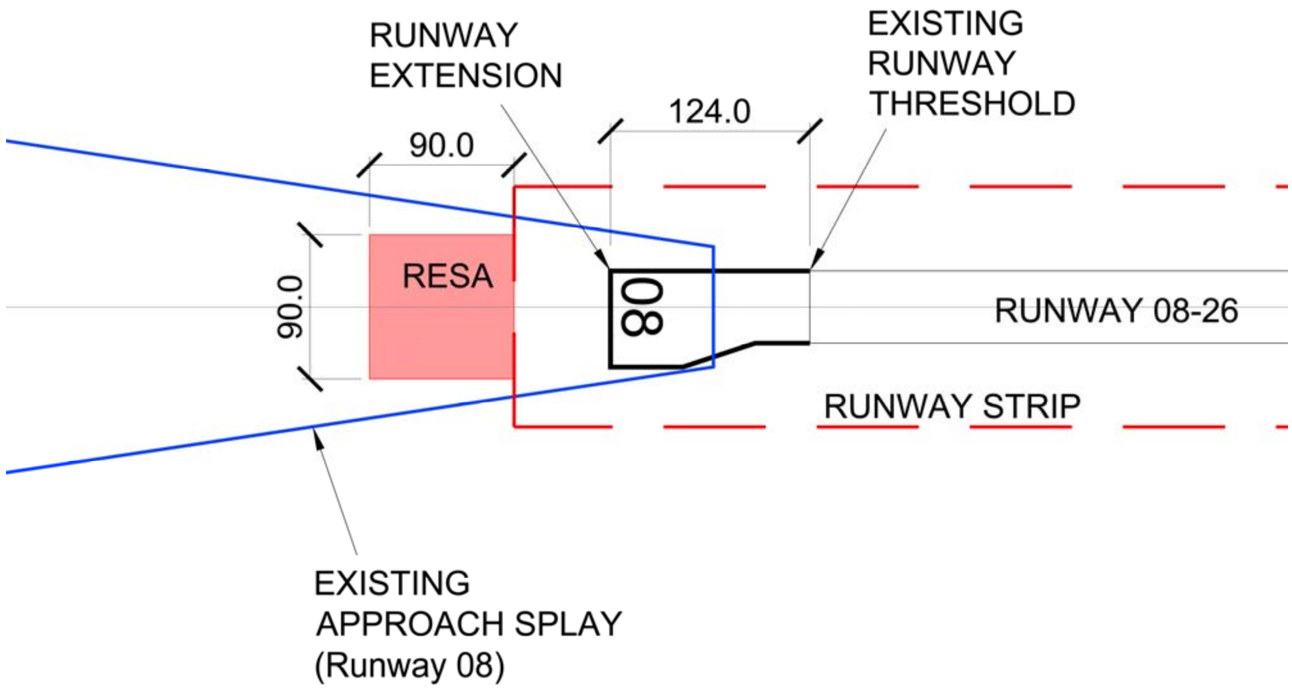

Fig 6.2 Indicative RESA Layout – Runway 08

In 2010, Transport Canada tabled NPA 2010-012 with the objective to harmonize Canadian Standards (TP312) in regard to RESA with international standards (ICAO Annex 14) hence making the 90m RESA mandatory. Section 302.551 of the NPA states that "A runway-end safety area shall be provided where the runway length is 1 200 m or greater"[55]. Furthermore, section 302.552 states that "a runway end safety area may not be provided prior to the declared Landing Distance Available (LDA) where one of the following is operational on the runway in use:
(a) Precision Approach Path Indicator (PAPI);
(b) Abbreviated Precision Approach Path Indicator (APAPI); or
(c) Instrument Landing System glide slope."

[55] http://wwwapps.tc.gc.ca/Saf-Sec-Sur/2/npa-apm/npaapmr.aspx?id=2806&lb=1&lang=eng

Considering that BBTCA's Runway 08-26 is over 1,200m long, RESA may have become a requirement upon application of this rule. This would require the TPA to either reduce the declared Take-Off Runway Available (TORA) on Runway 08-26 inducing possible range and payload restrictions on existing operations, or to undertake a RESA development project involving an extension of the airfield into the harbour similar to what is currently proposed, simply to maintain existing operational requirements, or by using an Engineered Material Arrester system (EMAS) which is proposed as an alternative to full length RESAs.[56] Considering that BBTCA currently operates under a Code 2 category, there may also be an opportunity to obtain an exemption on the need for RESAs subject to review by Transport Canada. The *Runway 08-26 Extension Study*[57] recommends the use of a portion of the RESA to provide additional length for take-off operations. A similar concept called Starter Extension in the United Kingdom and New Zealand[58] enables an aircraft to optimize the use of the RESA with reduced runway strip and runway width requirements for the initial stages of the take-off roll, to obtain a longer take-off runway length. Based on communication with Transport Canada, "If the RESA is to be used for the start of take-off operations then it is now officially "runway" and subject to the runway strip standards". As such, the provision of a 45m graded runway strip area initially appeared to be required before the commencement of the take-off roll as well as the provision of a full runway-strip. Further to Transport Canada advice, the TPA has now submitted a revised proposal which provides 21m graded runway strip (as opposed to 45m) between the seawall and the commencement of the take-off roll. The outcome of the present review is unknown.

TAXIWAYS

The runway lengthening proposal will have some impacts on the taxiway system at BBTCA. Currently operating as a Code 2 facility, the extension of the runway will bring this runway into a Code 3 category as confirmed by Transport Canada. This will in turn affect the width of the runway strip which, currently at 80 metres, will need to be widened to 150m. A runway strip is a defined area including the runway intended to reduce the risk of damage to aircraft running off the runway and to protect aircraft flying

[56] Advisory Circular (AC) No. 300-007, Transport Canada
[57] LPS AVIA, Runway 08-26 Extension Study, May 2013
[58] UK CAA http://www.caa.co.uk/docs/33/CAP168.PDF

over it during take-off or landing operations.[59]

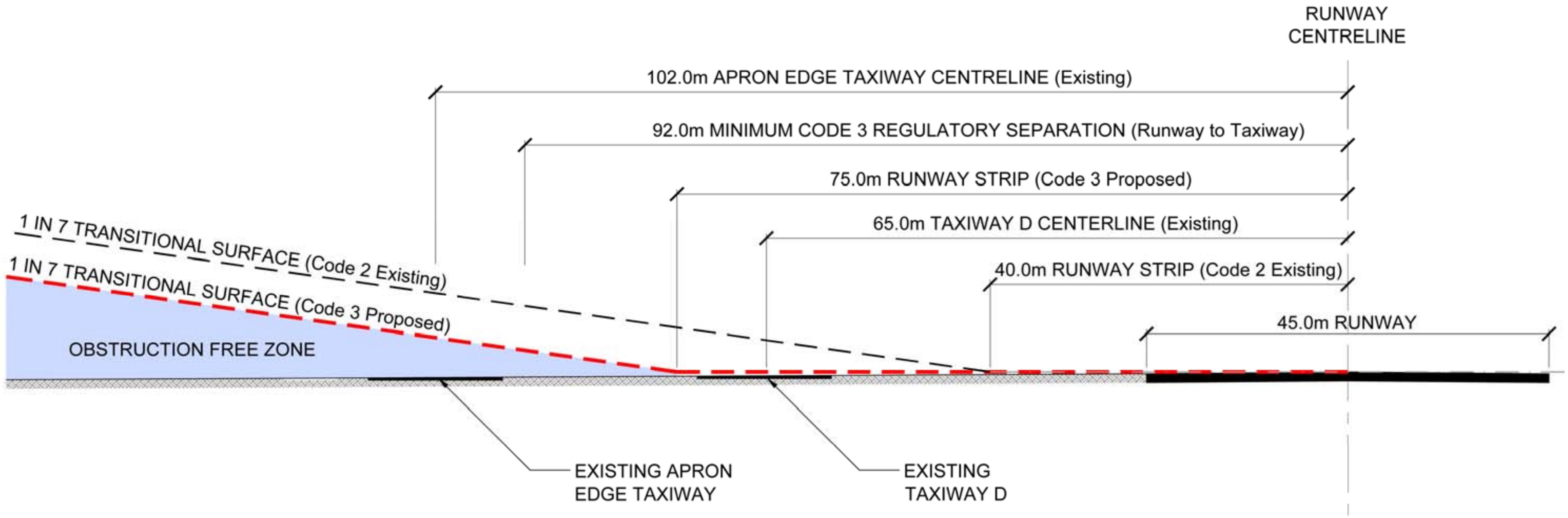

Fig 6.3 Code 2 and Code 3 Runway Strip Impacts – Cross-Section

The widening of the runway strip in turns affects the minimum separation requirements between the runway and parallel taxiway. Previously at 57.8m from the runway centreline to taxiway centreline, the minimum requirement under a Code 3 runway requirement would become 92.0m (International standards are 93.0m)[60]. At approximately 65m from Runway 08-26 centreline, Taxiway D would therefore breach the clearance requirements and would not be useable during Runway 08/26 operations.

Using the full length of the runway for take-off would therefore require backtracking by the aircraft, especially the CS100 since the Dash8-Q400 may still be able to operate from the intersection of a

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[59] TP 312 - Aerodromes Standards and Recommended Practices, Transport Canada, March 2005

[60] Annex 14 to the Convention on International Civil Aviation: Aerodromes Volume 1, Aerodrome Design and Operations ICAO, Fifth Edition, July 2009

taxiway with the runway. This could, however, lead to an overall reduction in the capacity of Runway 26.

The apron-edge taxiway centreline (running parallel to Runway 08-26) is approximately 102 metres from the runway centreline and therefore meets the minimum requirement of 92m.
To offset the capacity reduction associated with the need to backtrack on the runway for take-off operations (and possibly landings), the provision of extended compliant taxiways to both runway ends has been considered.
The following figures and table highlight the additional areas of landmass required to support a compliant taxiway system at both runway ends.

	Proposal #1 (168m)	Proposal #2 (200m)
Western Taxiway Area	8,800 m^2	10,200 m^2
Eastern Taxiway Area	15,900 m^2	17,300 m^2
Total Taxiway System Area	24,700 m^2	27,500 m^2

Table 6.1 Additional Taxiway Landmass Requirements

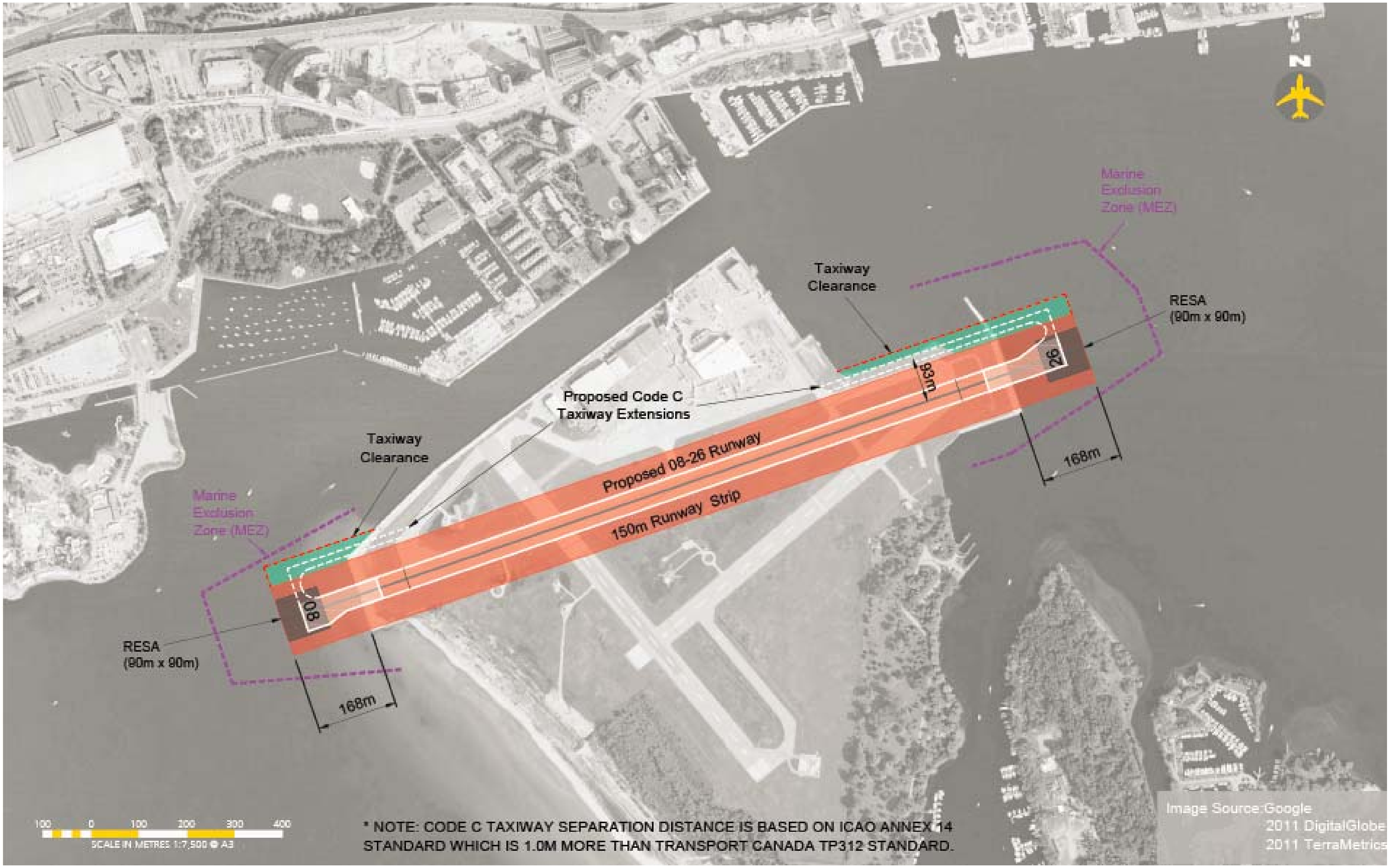

Fig 6.4 Proposal #1 – 168m extension Taxiway Reserve

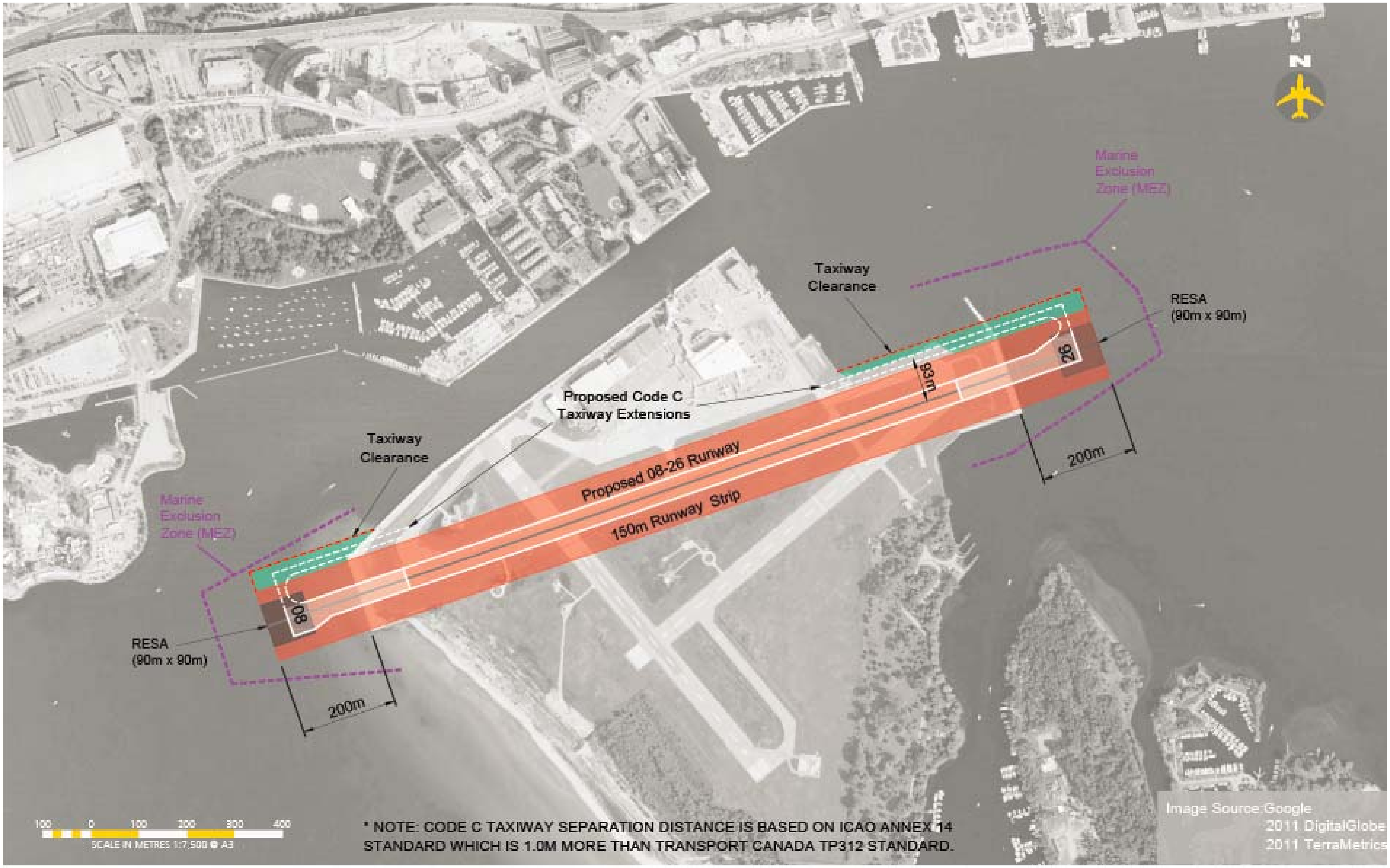

Fig 6.5 Proposal #2 – 200m extension Taxiway Reserve

APRON

The apron used for aircraft parking will be affected by the present proposal. As previously explained, a change of the runway code from 2 to 3 would require a wider runway strip (increased from 80m to 150m).[61] The OLS transitional surface originates from the edge of the runway strip and therefore the OLS transitional surface would shift 35m towards the apron which would in turn impose more stringent height restrictions over this area.

Although Dash8-Q400 aircraft would still be able to park at the gates on the southern face of the passenger terminal building (subject to a formal site survey confirming obstacle clearances), the CS100's length and height would prevent it from being parked at these southern gates. The opportunity to park the CS100 aircraft would therefore be limited to the western and eastern faces of the existing terminal. As existing Q400 aircraft parking positions are designed with minimum wingtip clearances, per Transport Canada regulations, the wider CS100 would need a realignment of the gates to allow for appropriate wingtip clearance at the western and eastern gates of the terminal. The following figure illustrates the apron impacts of the proposed runway extension.

[61] TP 312 - Aerodromes Standards and Recommended Practices, Transport Canada, March 2005

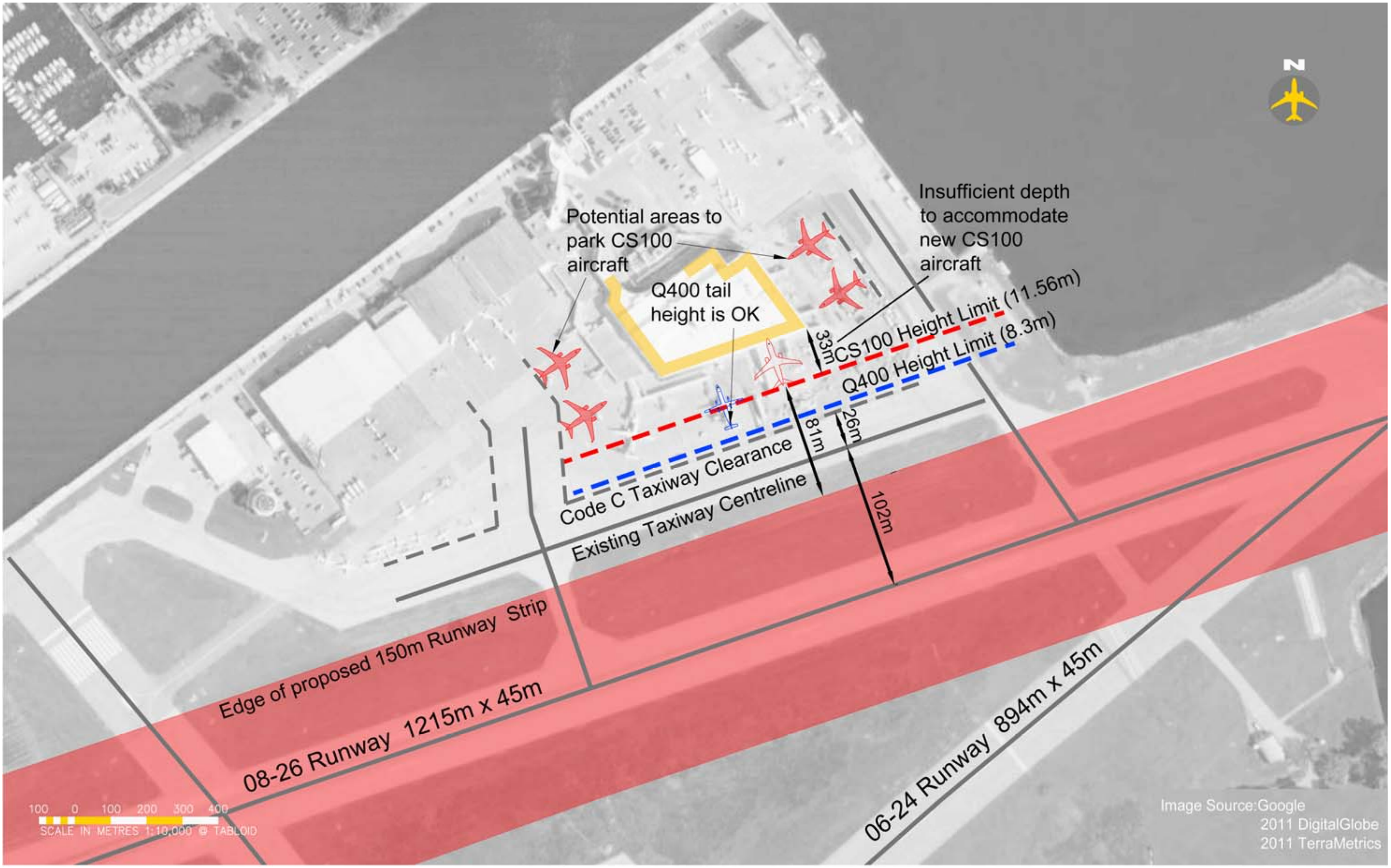

Fig 6.6 Code 3 Runway and Concept Apron Parking Plan with associated clearances

JET BLAST CONSIDERATIONS

Jet blast was identified as a possible issue to address as part of this review. Comparable aircraft to the CS100 were initially considered to highlight the area affected by various jet blast wind speeds. The Airbus A318 and the Boeing 737-600 were selected for this assessment using the worst case expansion scenario (200m runway extension). They are characterized by similar engine thrust levels but have lower air bypass ratios compared to the CS100.

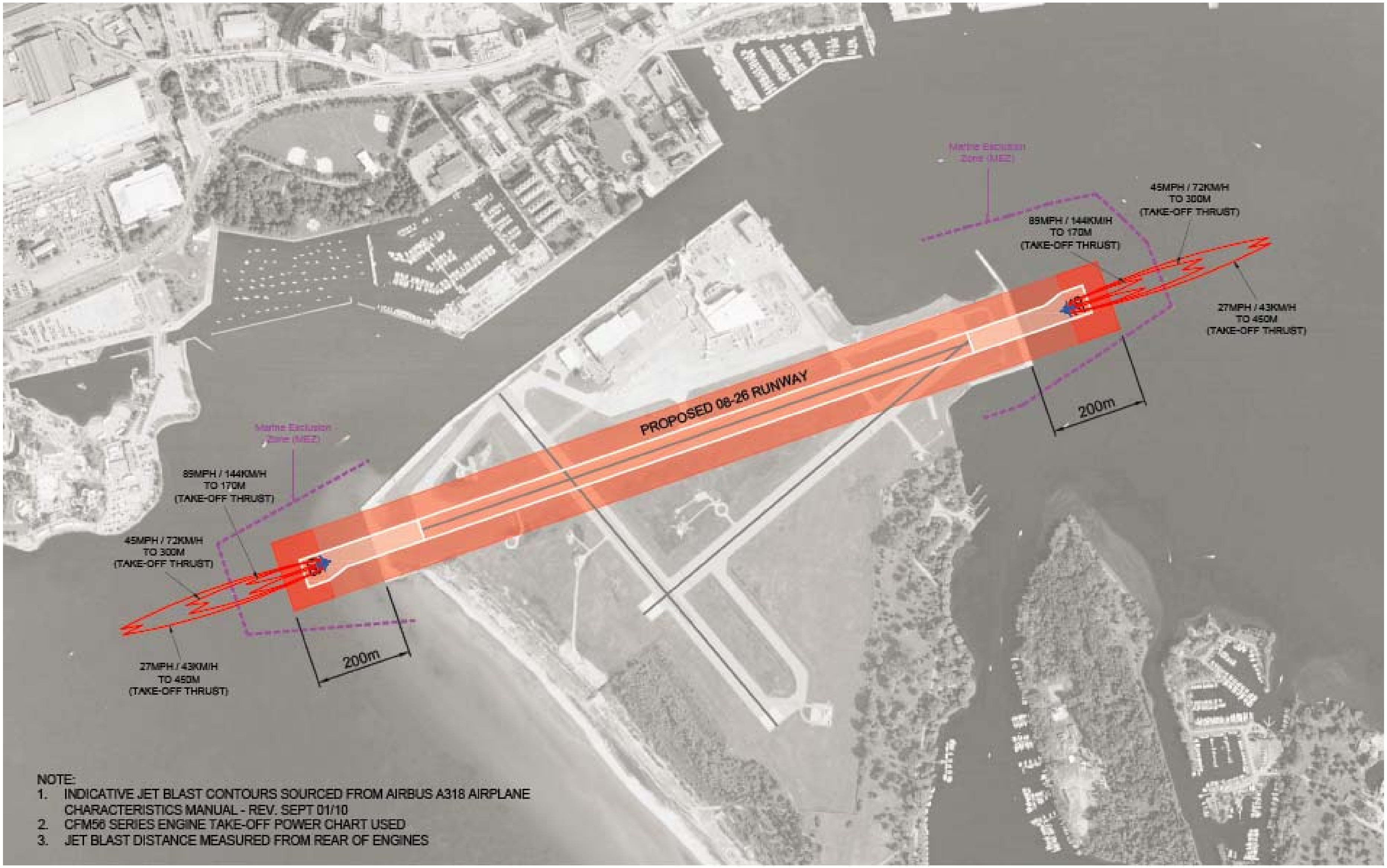

Fig 6.7 Jet Blast Envelopes – A318 Take-Off Thrust

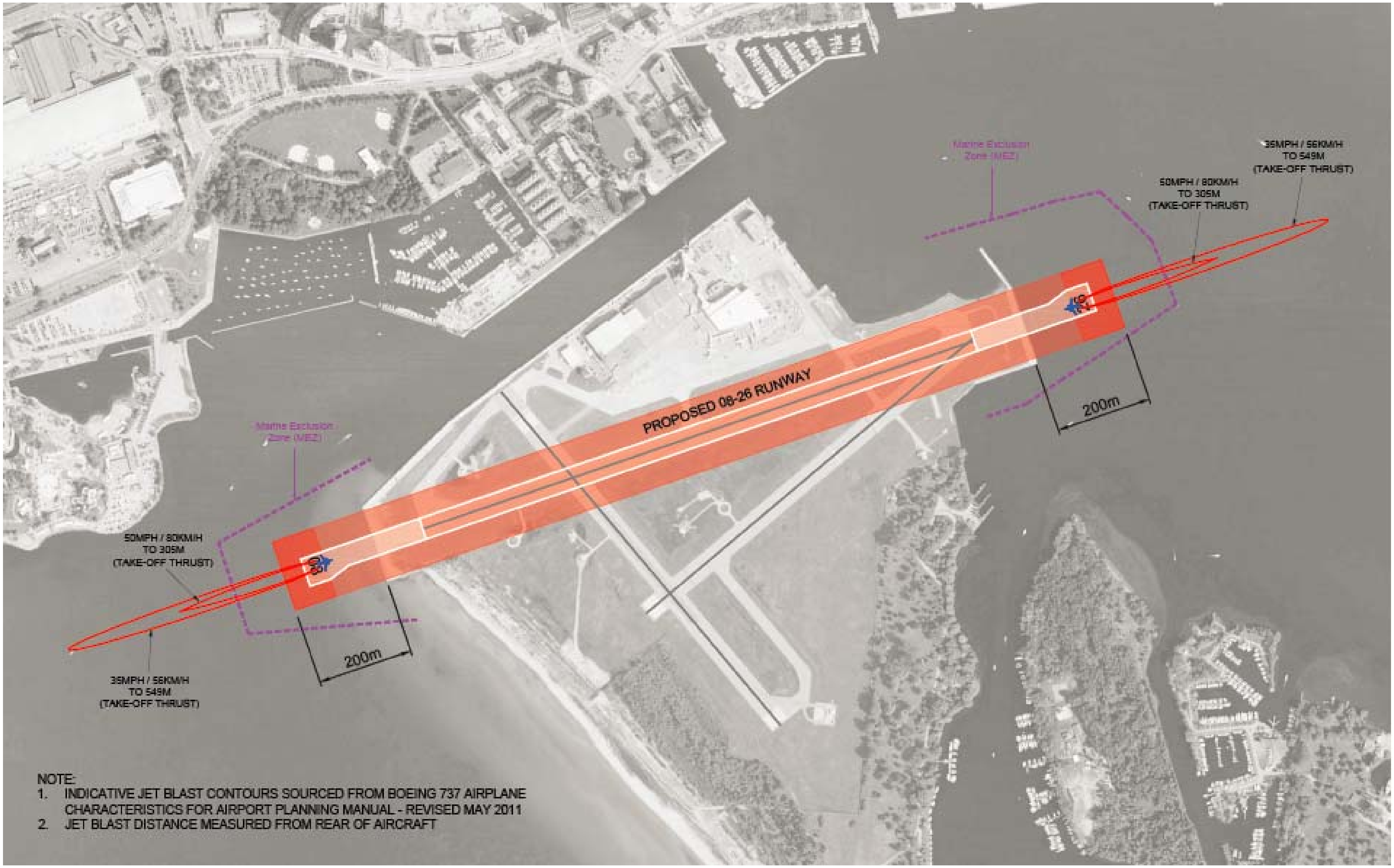

Fig 6.8 Jet Blast Envelopes – B737-600 Take-Off Thrust

Both aircraft types would impose take-off jet velocities in excess of 60 km/h outside of the MEZ which may affect harbour navigation. However, these aircraft are known to exceed the noise certification levels currently set in the Tripartite Agreement. The technology used by aircraft scheduled to begin commercial operations over the coming years will lead to an increase in the engine air bypass ratio. The bypass ratio is determined by the air mass that bypasses the engine's core over the air mass entering the engine combustor. A higher bypass ratio will lead to a decrease in the jet velocity which is also a contributor to noise levels.[62]

Preliminary data was sourced from Bombardier for the CS100 and is highlighted in the following tables for breakaway thrust (i.e. thrust required to initiate the movement of an aircraft from a standstill position) and for take-off thrust (i.e. thrust required at Take-Off).

Velocity (m/sec)	Distance (m)
10	99
25	44

Table 6.2 CS100 Breakaway Thrust – Jet Blast Velocity[63]

For the breakaway jet velocity data, Pratt & Whitney advised that the validation was performed with a 20 knot headwind which may have increased the distance highlighted above. These values should, therefore, be considered as conservative and may prove to be smaller at the outcome of the ground tests.

Velocity (m/sec)	Distance (m)
15	163
25	99
30	84

Table 6.3 CS100 Take-Off Thrust – Jet Blast Velocity[64]

[62] Cumpsty N, Jet Propulsion, 2nd edition, 2003
[63] Bombardier Aerospace

To enable a relative comparison with the B737-600 and A318 aircraft take-off thrust, the following indicative layout highlights the distance of each velocity range from the rear of the engines. This drawing is based on Porter Airlines' Proposal #2 (200m) and a 45m clearance at the end of the runway. This is now known to have been reduced to 21m following consultations with Transport Canada in a subsequent submission.

[64] Bombardier Aerospace

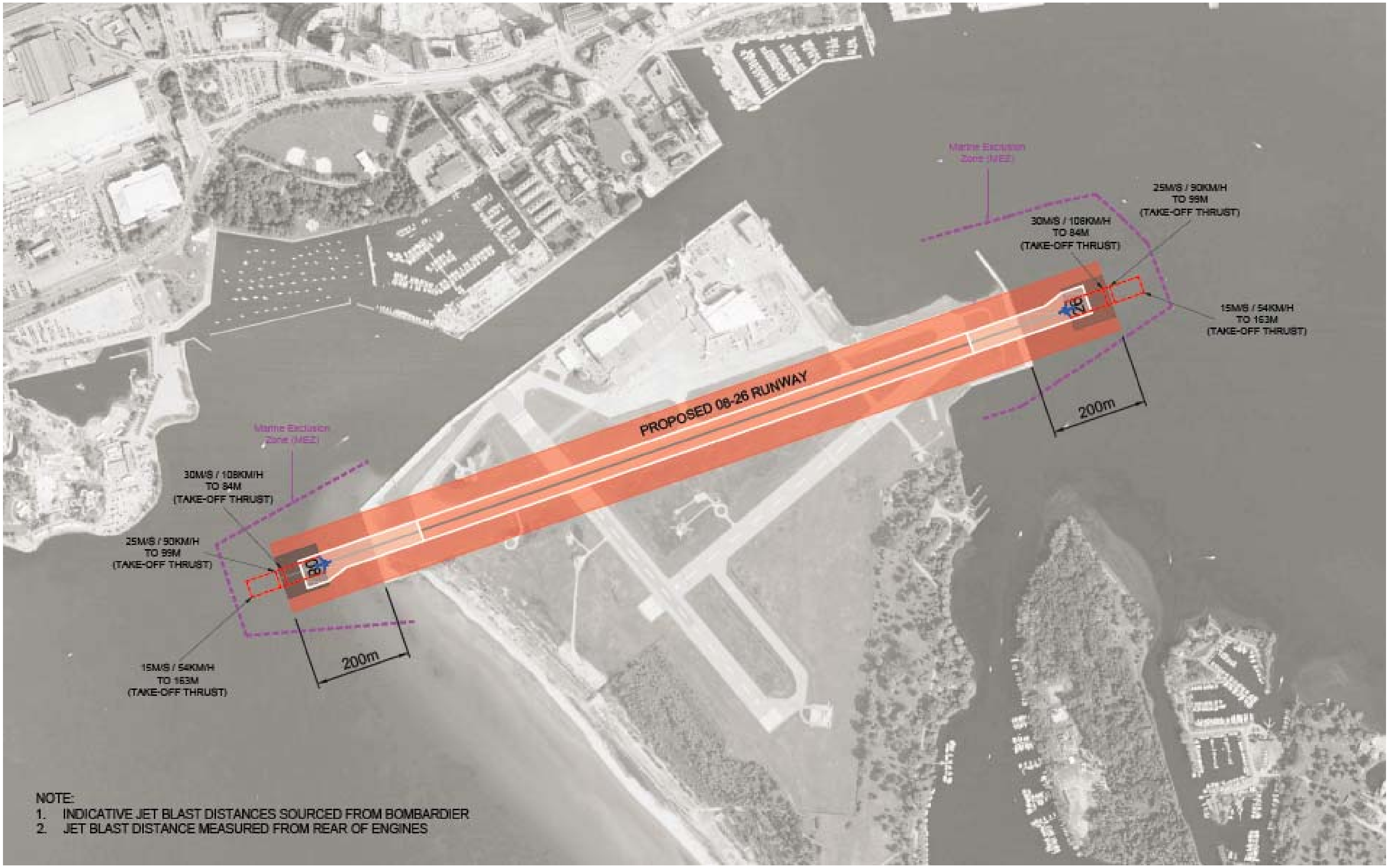

Fig 6.9 Jet Blast Indicative Extent – CS100 Take-Off Thrust – Proposal #2 (200m Extension)

This drawing highlights significant reductions in the extent of the jet blast impact for the CS100 compared to the A318 and B737-600. Such reduced jet velocities may still have an effect on harbour navigation which should be further investigated, as well as the effects from other potential existing and future jet aircraft. The reduced clearance at each runway end will result in the jet blast envelopes extending 24m further into the harbour and should be included in future studies. The effects of jet blast on harbour navigation were reviewed by CH2M HILL and goes beyond the scope of the present study.

PAVEMENT STRENGTH

The Transport Canada Engineering Reference Document "Canadian Airport Pavement Bearing Strengths TP2162" as well as the BBTCA Airport Operations Manual defines the pavement strength of Runway 08/26 as follows:

Specification	Value
Pavement Load Rating (PLR)	6
Tire Pressure Limit	1.0 MPa
Pavement Classification Number (PCN)	11/Flexible/Medium Strength/Technical Evaluation

Table 6.4 Existing Runway 08/26 Pavement Rating

A specific authorization must be obtained from the Airport Operator for operation of aircraft with load ratings or tire pressures exceeding values shown above. An aircraft such as the CS100 and comparable aircraft will have ALR (Aircraft Load Rating) and ACN (Aircraft Classification Number) in excess of what is currently specified at BBTCA. The ALR is a number developed by Transport Canada expressing the relative structural loading effect of an aircraft on a pavement based on 12 groups according to their pavement strength requirements.[65] The ACN is an ICAO number expressing the relative structural loading effect of an aircraft on a pavement for a specified pavement type and a specified standard subgrade category.

A more detailed study on the required pavement upgrades is recommended for the existing runway, taxiway and aprons. The appropriate ALR and ACN need to be confirmed and a scope of work defined to confirm the extent of work and associated costs related to the pavement ratings at BBTCA.

The cost estimates within this preliminary report do not make provisions for pavement upgrades to

[65] Canadian Airport Pavement Bearing Strengths TP2162

existing facilities as this is within the purview of the TPA.

PASSENGER TERMINAL

As described in the previous section, the passenger terminal currently has a capacity of approximately 720 passengers (origin/destination) per hour, each way.[66] Although the Porter Airlines proposal is focussed on the proposed runway extension, the ability of the airport to cater for the CS100 (or equivalent) jet aircraft would require expansion work at the passenger terminal to allow passengers to board this aircraft and to process the additional passenger demand that may result from the operation of larger aircraft during the busy hours. Cost estimates within this preliminary report do not make provisions for gate and passenger terminal upgrades that cater the new aircraft and the additional passenger demand as this is within the purview of Porter Airlines.

GROUNDSIDE

Groundside includes the interface with the ground transportation systems such as taxis, buses, private cars and pedestrians. This review is limited to the assessment of passenger volumes that are anticipated to interface between the passenger terminal and the various ground transportation options. The BBTCA and Eireann Quay Strategic Transportation Study will take these passenger counts and conduct their own studies and present findings to the City. The anticipated passenger volumes that are expected under the auspices of the Porter Airlines proposal are:

- 3.2 million origin and destination (O/D) passengers/annum; and
- 910 O/D passengers/hour.

The main process currently affecting the flow of passengers between groundside and the passenger terminals is the ferry link. This ferry link will soon be complemented by an underground pedestrian tunnel which will have the effect of easing the sporadic peaks currently experienced on groundside whenever a ferry was docking, four times an hour. The anticipated combined peak hour capacity of the ferry and the tunnel is:

- Ferry, 800 passengers/hour each way;
- Tunnel, 1,066 passengers/hour each way; and
- Maximum combined capacity, 1,866 passengers/hour each way.

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[66] Airbiz, Peer Review – 2010 Capacity Study

This review confirms that the pedestrian tunnel will add enough capacity in both directions to process the projected busy hour demand associated with the possible introduction of the CS100 at BBTCA.

FUEL HANDLING

The Dash8-Q400 and CS100 use the same type of jet fuel. However, the CS100 has a larger fuel capacity that enables it to operate longer stage lengths, including to trans-continental destinations. The following table outlines some key specifications associated with each aircraft with regard to fuel capacity as well as associated payload and range.

Specifications	Dash8-Q400	CS100
Fuel Capacity	6,616 L	~22,000 L
Aircraft Range[67]	2,063 km	5,463 km
Average Stage Length[68]	~600 km	~2,400 km
Maximum Take-Off Weight	29,574 kg	58,513 kg

Table 6.5 Key specifications – Payload-Range-Fuel Uplift

Based on a single flight being up-gauged from a Dash8-Q400 operating a short-haul sector to a CS100 operating a medium-haul sector, the incremental growth in fuel flowage will be approximately 4 times more for a CS100 than for a Dash8-Q400. This does not take into account the ability of the CS100 to operate on existing routes where less fuel would be required.

[67] Range is based on 102 kg per passenger, 74 pax (Q400) and 110 pax (CS100)
[68] Average range of existing (Q400) and projected (CS100) markets currently served at YTZ.

SUMMARY – PROPOSAL #1

The following chart highlights the key findings from our review of infrastructure requirements for Proposal #1 (168m extension at each end). Based on advice from the Toronto Port Authority, this proposal is not being reviewed by Transport Canada.

Item	Description
1	Review of declared distances should be undertaken with Transport Canada based on obstacles on take-off.
2	Runway-End Safety Areas are to be provided at both ends and used to provide additional runway length on take-off. The proximity of the start of the take-off roll from the harbour indicates a potential risk associated with jet blast from jet aircraft which should be reviewed at a more detailed level.
3	Approach surfaces remain unchanged but runway thresholds will be displaced by 60 metres subject to Transport Canada review.
4	Runway will become Code 3C resulting in the runway strip being widened to 150m and displacing the Transitional Surfaces.
5	Insufficient minimum separation between Taxiway Delta and Runway 08-26. Additional taxiways may be required to maintain airfield capacity during busy periods.

Table 6.6 Infrastructure Requirements – Summary of Findings – Proposal #1

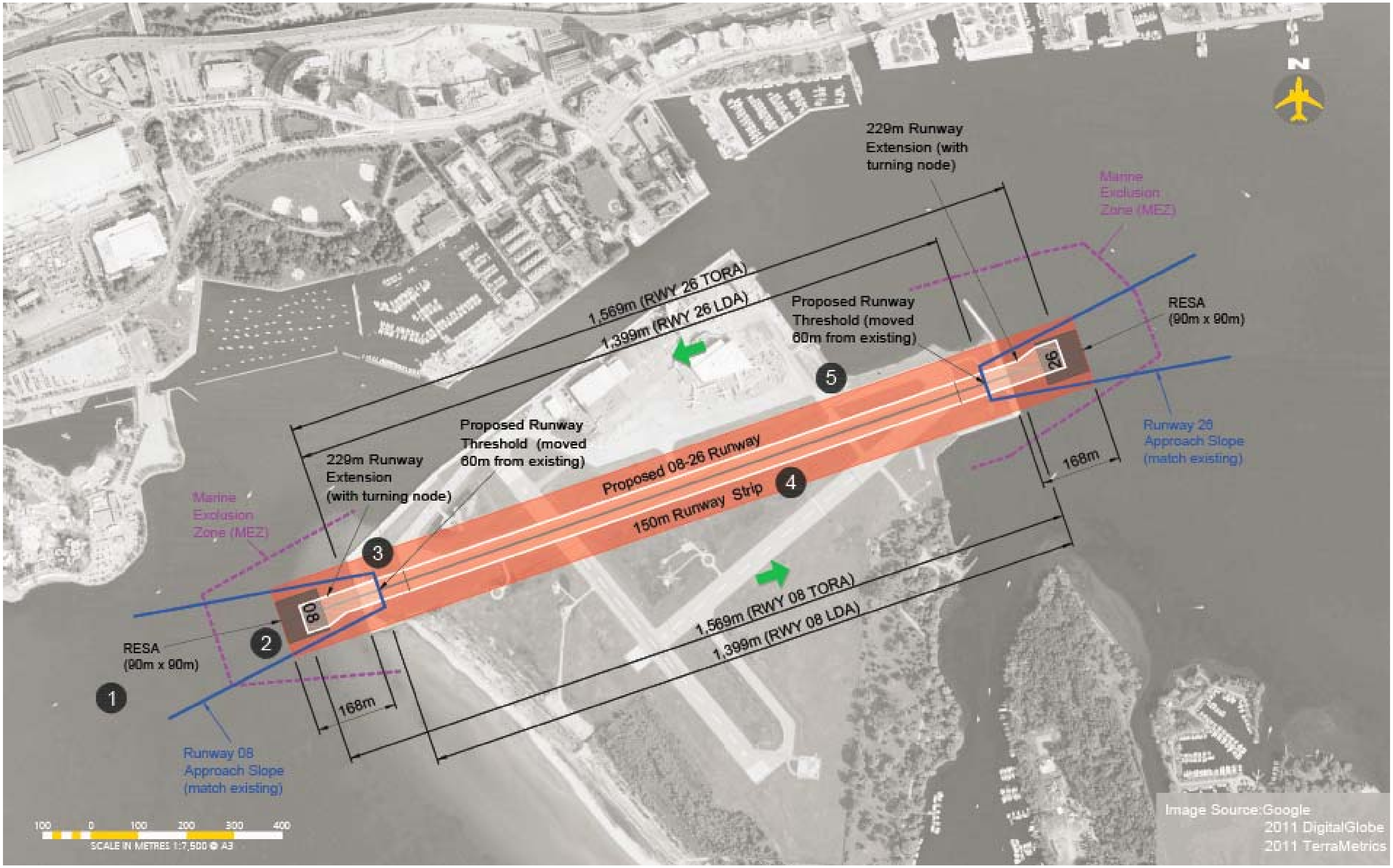

Fig 6.10 **Infrastructure Requirements – Summary of Findings – Proposal #1**

SUMMARY – PROPOSAL #2

The following chart highlights the key findings from our review of infrastructure requirements for Proposal #2 (200m extension at each end). Based on advice from the Toronto Port Authority, this proposal was formally submitted for review to Transport Canada.

Item	Description
1	Review of declared distances should be undertaken with Transport Canada based on obstacles on take-off.
2	Runway-End Safety Areas are to be provided at both ends and used to provide additional runway length on take-off. The proximity of the start of the take-off roll from the harbour indicates a potential risk associated with jet blast from jet aircraft which should be reviewed at a more detailed level.
3	Runway thresholds remain unchanged but approach surfaces will be displaced by 60 metres inland subject to Transport Canada review.
4	Runway will become Code 3C resulting in the runway strip being widened to 150m and displacing the Transitional Surfaces.
5	Insufficient minimum separation between Taxiway Delta and Runway 08-26. Additional taxiways may be required to maintain airfield capacity during busy periods.

Table 6.7 Infrastructure Requirements – Summary of Findings – Proposal #2

Following the review, a new proposal was submitted by the Toronto Port Authority on 29 October 2013 which increased the length available for take-off operations. This does not impact the summary above but will increase the Take-Off Run Available (TORA) from 1,632m to 1,656m.[69]

[69] Porter Airlines Runway 08-26 Extension Study Billy Bishop Toronto City Centre Airport, October 29, 2013, LPS AVIA Consulting

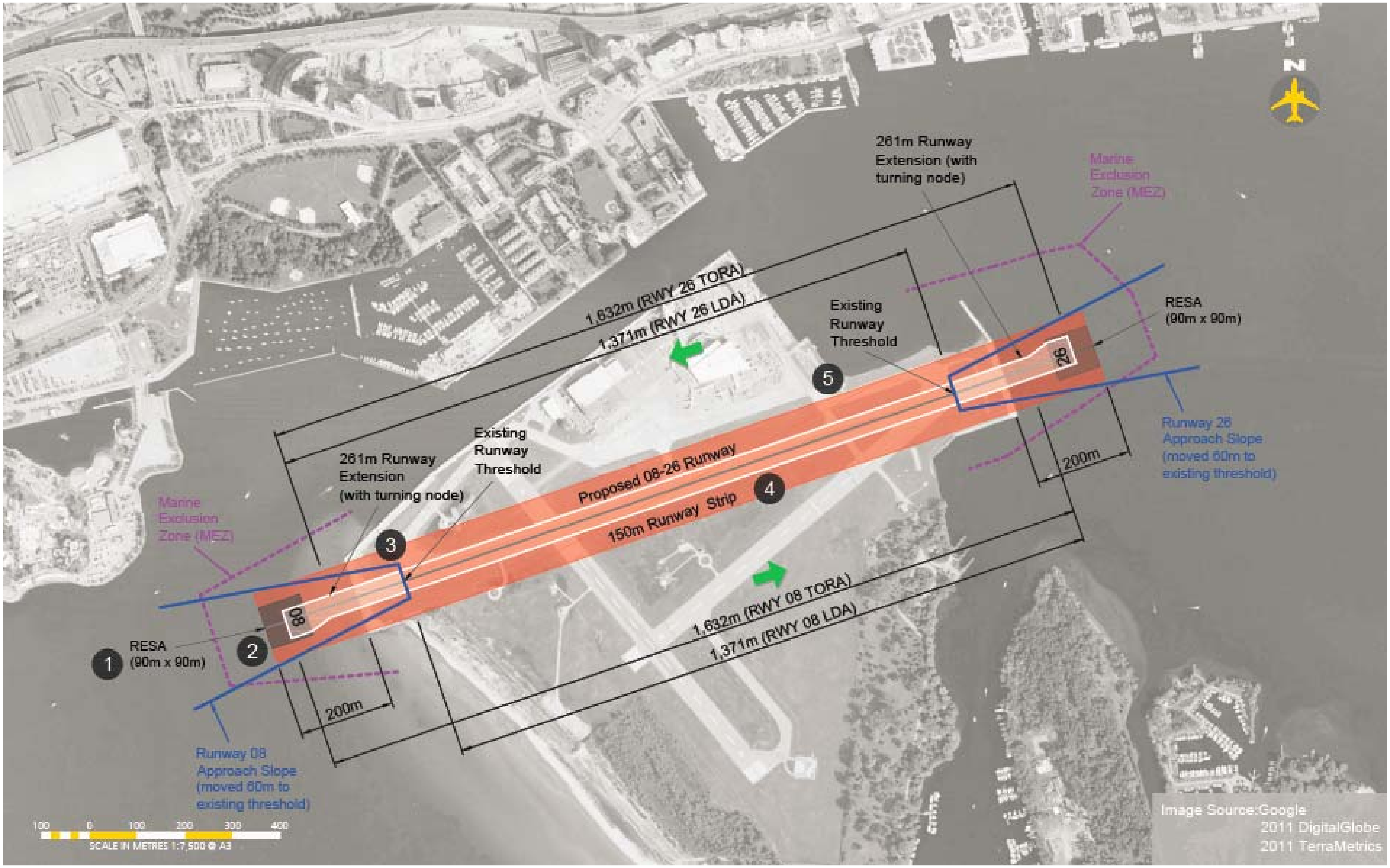

Fig 6.11 Infrastructure Requirements – Summary of Findings – Proposal #2

07. NOISE CONSIDERATIONS

This section reviews the noise considerations associated with lifting the ban on jet aircraft operations at the Billy Bishop Toronto City Airport and more specifically the considerations of the potential noise impacts associated with the Bombardier CS100.

DESCRIBING AND MEASURING AIRCRAFT NOISE

Aircraft noise is the sound emitted through the operation of aircraft during all phases of flight. Aircraft noise is induced primarily by the engines (or propellers) as well as the airframe of the aircraft including the landing gear, slats and flaps. Individuals do not experience a uniform response to sounds of the same intensity generated at different frequencies.

Aircraft sound can be measured accurately using a range of metrics depending on the objective sought. Attempting to correlate these metrics with impacts on the community is complex as aircraft noise as experienced by an individual is highly subjective. Unbearable noise for one person might not be of any concern at all to another.[70] Human perception of noise depends generally on three factors: frequency; level; and duration. The chart below illustrates the audible range of a typical human ear based on frequency (0-20,000 Hz) and sound pressure level (SPL, 0-130 dB). The duration of a noise event will also be a significant contributing factor to annoyance.

[70] The Truth About Aircraft Noise, Australian Noise Ombudsman, January 2013

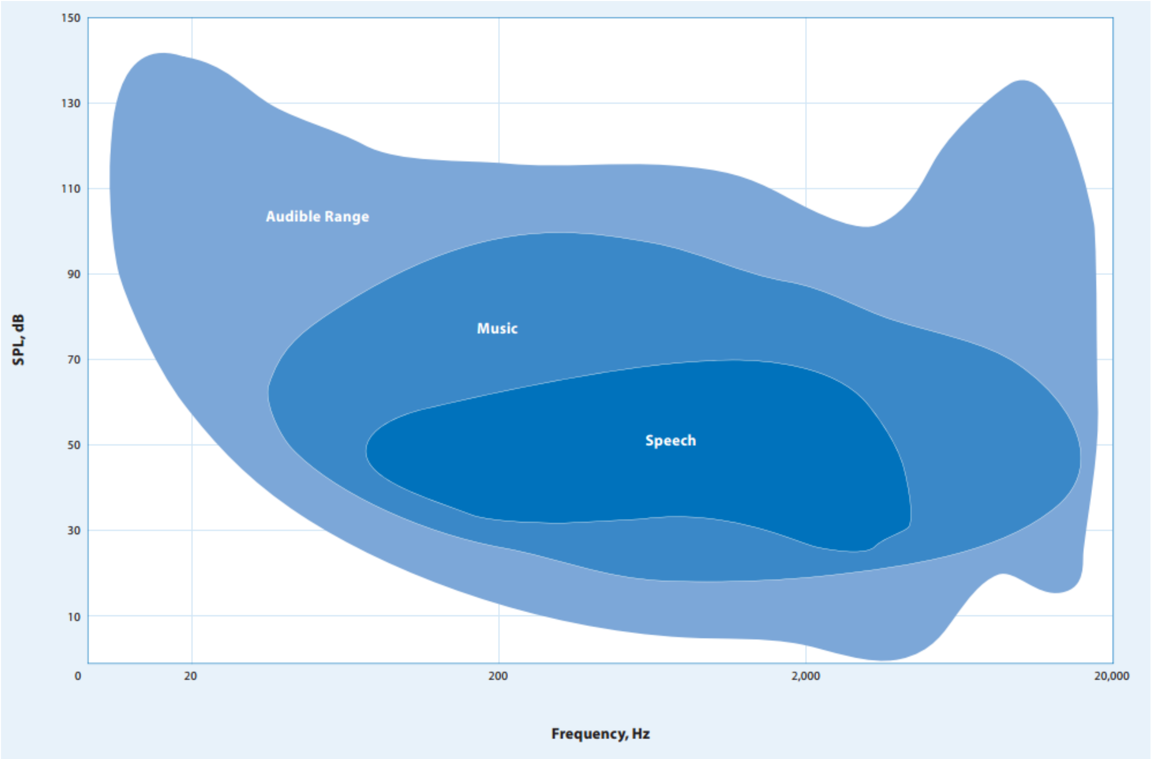

Fig. 7.1 Hearing range – frequency and level [71]

The human ear does not perceive sound the same way across all frequencies. Low-pitch noise is less perceptible to the human ear but may lead to secondary effects such as window rattling and vibrations. High-pitch noise is generally more annoying as it includes squealing and screeching noise. To take account of the variation of this perception, various methods of frequency weighting have been developed. The A-Weighted scale (dBA) is the most commonly used scale because it weighs down the impact of low and high frequency noises. The C-Weighted scale (dBC) is used but its purpose is to also

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[71] Oakland International Airport Master Plan Update (2006)

account for non-audible impacts of noise such as impulsive sounds creating vibration. The following chart illustrates the weighting used for these two scales.

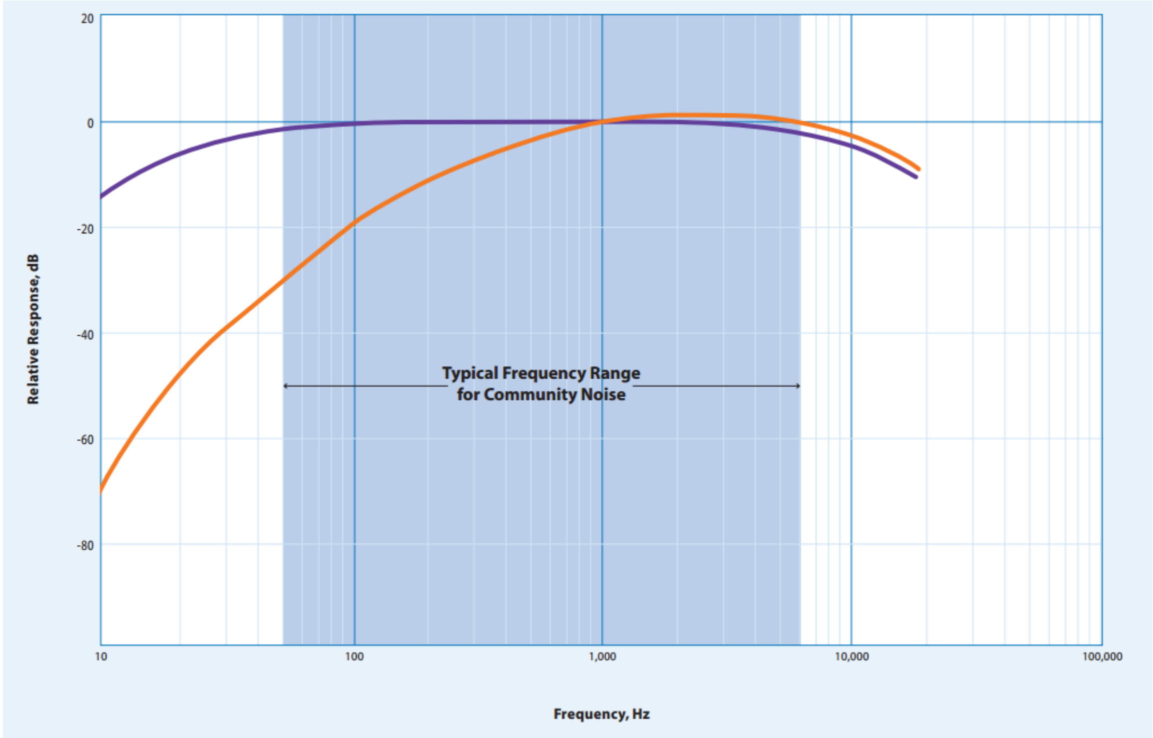

Fig. 7.2 Frequency Weighting – A-scale (orange) and C-scale (purple)[72]

When discussing noise, several metrics are used. There are three broad types of noise metrics:

- Those that express noise **cumulatively** as a function of total energy experienced over a set period of time;
- Those that express the noise levels experienced during a **discreet** aircraft operation; and
- Those that are a **hybrid** of the first two. [73]

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[72] Oakland International Airport Master Plan Update (2006)
[73] Airport Cooperative Research Program Report 15: Aircraft Noise: A Toolkit for Managing Community Expectations (2010)

CUMULATIVE NOISE METRICS

All cumulative noise metrics are expressions of the total amount of acoustic energy that is present. Most express an average of the noise energy that occurs during a selected period of time. Based on the needs of the government/ jurisdiction where each is applied, they often are adjusted to weigh more heavily on periods of the day that are considered to be noise-sensitive, such as night time.

Noise Exposure Forecasts (NEF)

In Canada, the NEF metric is used to evaluate noise exposure as a means to encourage appropriate land use planning. It is a single number metric which cumulates all events across a busy day as determined by a methodology outlined by Transport Canada.[74] The noise levels are sourced from a database contained in the Transport Canada NEF-CALC software.

Equivalent Sound Level (Leq)

This metric represents a steady-state noise level over a specified time period. It is effectively a sum over that time period and is, thus, a measure of the cumulative impact of noise. Leq can be measured for any time period, but is typically measured for 15 minutes, 1 hour, or 24 hours. It is used where sound levels vary over time as a means to assess the impact of cumulative noise exposure.

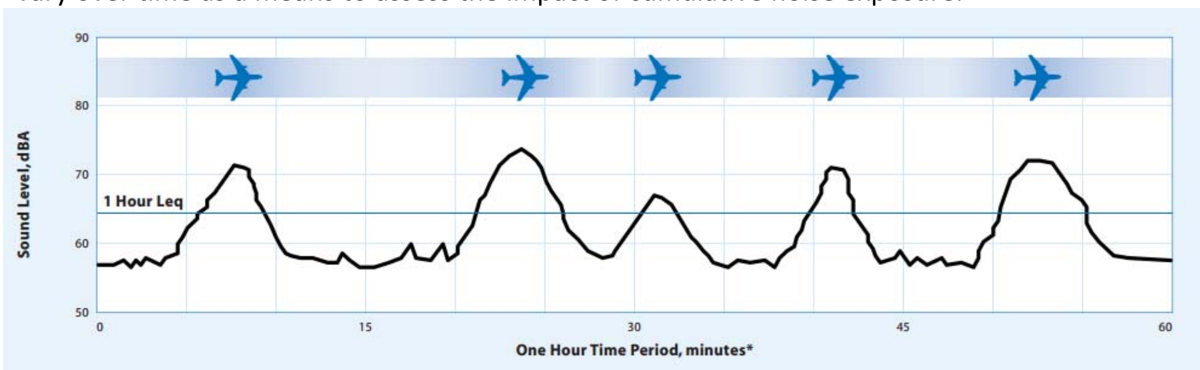

Fig. 7.3 Equivalent Noise Level (Leq) - example[75]

[74] TRANSPORT CANADA, Aviation Group, « NEF micro computer system user manual », June 1990, TP 6907

[75] Oakland International Airport Master Plan Update (2006)

SINGLE EVENT NOISE METRICS

Cumulative aircraft noise contours often are challenged by airport neighbors as not representing what can be heard and measured every time an aircraft flies near their home. Long duration measurements and computer technology may indicate the contour patterns are appropriate for community planning, but they fail to capture the discrete nature of the single events that people actually identify and complain about.

As louder Chapter 2 aircraft[76] were removed from the commercial operating fleet during the 1990s, cumulative noise contours shrank significantly from earlier sizes. Although the contour reduction could be attributed largely to the reduction of noise from individual aircraft, the number of actual operations has generally increased. As a consequence of this change, the public has become more vocal in demanding that the number and noise levels of single events be assessed within environmental evaluations. Several metrics are available to respond to this demand.

The following are examples of single event noise metrics:

Sound Exposure Level (SEL)

The SEL is a mathematical expression of the noise energy present during an event or a period of time, normalized to a single second.

It provides the noise analyst the ability to directly compare the acoustic energy generated by two separate events while clearly accounting for both their peak noise levels and durations. For example, the same operation may be considered along an existing and proposed flight track. The SEL of each operation would be compared to provide insight into the prospective effects of changing location on the underlying population. Further, the SEL is the preferred metric for the evaluation of sleep disturbance, making it critical to the evaluation of noise abatement measures that are directed towards night operations.

Maximum Sound Level (Lmax)

The maximum sound level corresponds to a single maximum value recorded during a given noise event. Although it can easily be measured, it does not correlate well with public perception as it does not include the notion of duration or a spectrum of the sound.

[76] ICAO Annex 16 Volume 1:Environmental Protection – Aircraft Noise

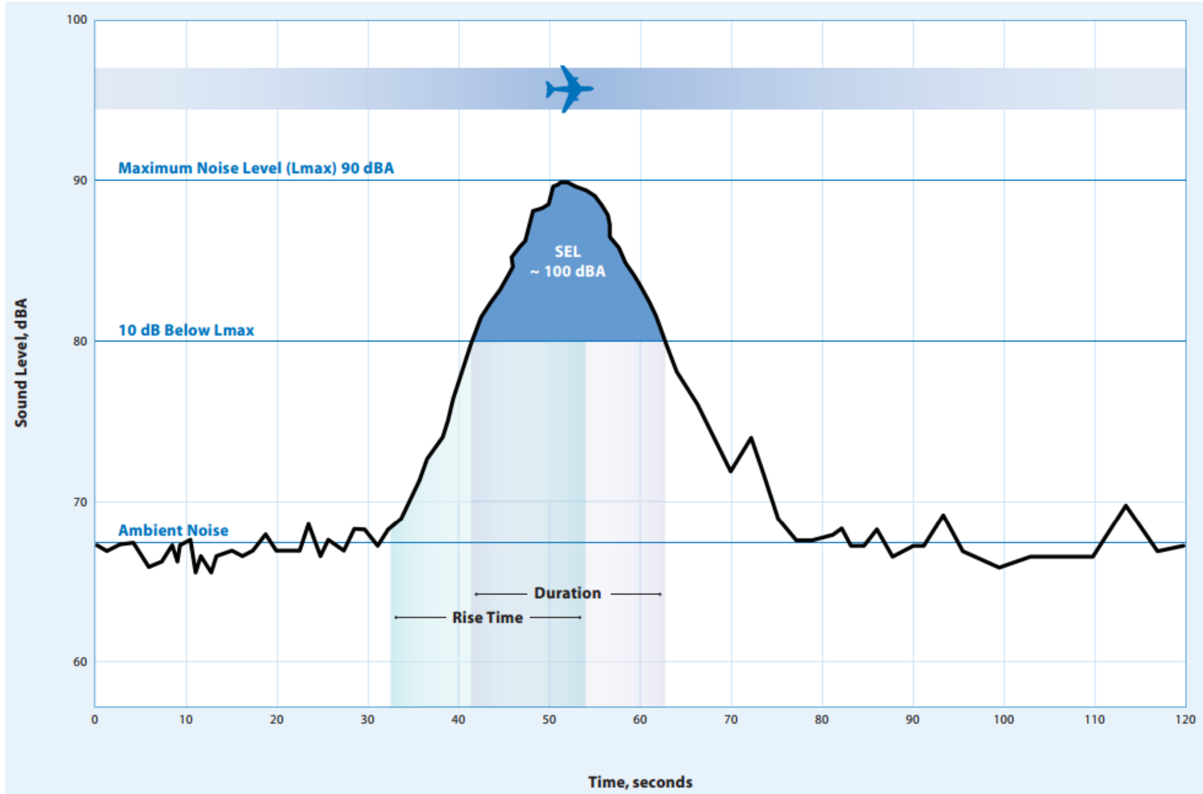

Fig 7.4 Sound Exposure Level (SEL) and Maximum Noise Level (Lmax) - example [77]

Effective Perceived Noise Level (EPNdB)

This metric is a measure of human annoyance to aircraft noise which has special spectral characteristics and persistence of sounds. It accounts for human response to spectral shape, intensity, tonal content and duration of noise from an aircraft. It is used by national regulatory bodies to certify noise levels of aircraft models entering the market.

[77] Oakland International Airport Master Plan Update (2006)

HYBRID NOISE METRICS

Also called alternative noise metrics, tools have been developed to enable a more responsive approach to public interests and to be easily understood by non-experts. These metrics are typically formed from combinations of simpler single event metrics.

NA (Number of Events Above)

The NA contours relate to the quantity of events above a certain noise threshold. N70 (70 dbA) is often used for daytime assessment while N60 (60 dBA) is used for night-time assessments. This metric has increasingly become popular over time because of its transparency and how it captures an increased paradigm shift in the source of aircraft noise annoyance.[78] While noise impacts were historically driven by event loudness, the improvements in engine and airframe technology were offset by increased aircraft operations. While cumulative noise exposure contours may show no changes or improvements, NA contours will have captured the actual quantity of noise events reaching a perceptible noise level.

BBTCA CONSIDERATIONS

Several of the discussed noise metrics have been used under a range of circumstances in relation to the BBTCA, notably the EPNDB, NEF and Leq. Because the CS100 is in a testing phase, the EPNdB is the most reliable comparable metric at this time. However, it should be noted that this metric is based on testing conditions that may not be experienced at the BBTCA due to varying operational procedures. It is therefore appropriate to confirm compliance to the levels set in the Tripartite Agreement using this metric, but it should not be interpreted as a confirmation that the perception of noise by the community will be identical for two aircraft with the same or similar certification noise levels.

There is no single metric that can compare two different noise events or cumulative sound exposure accurately because of the inherent differences in perception between people. As such, the most appropriate and transparent course of action involves the use of several metrics, including quantifiable non-auditory metrics such as the number of events.

The Toronto City Airport Noise Management Study (Jacobs, 2010) used a combination of periods of 1 second and 20 minutes for attended monitoring stations, as well as 10 minutes and 1 hour for unattended stations. This metric is especially appropriate when monitoring successive sounds originating from a range of sources.

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[78] Expanding Ways to Describe and Assess Aircraft Noise, DOTARS Australia, March 2000

EFFECT OF WEATHER ON SOUND

Noise propagates across the air from the transmitter to the receptor. As it travels towards the receptor, sound energy is dispersed but is also absorbed. The extent of atmospheric absorption varies widely based on weather conditions such as temperature, wind and humidity.
For example, sound will travel further in hot and humid conditions than in cold and dry conditions.
Wind direction and speed will also have a significant bearing on noise levels reaching the receptor.
Sound frequency will also be a consideration with high frequencies being more absorbed by the air than low frequencies.

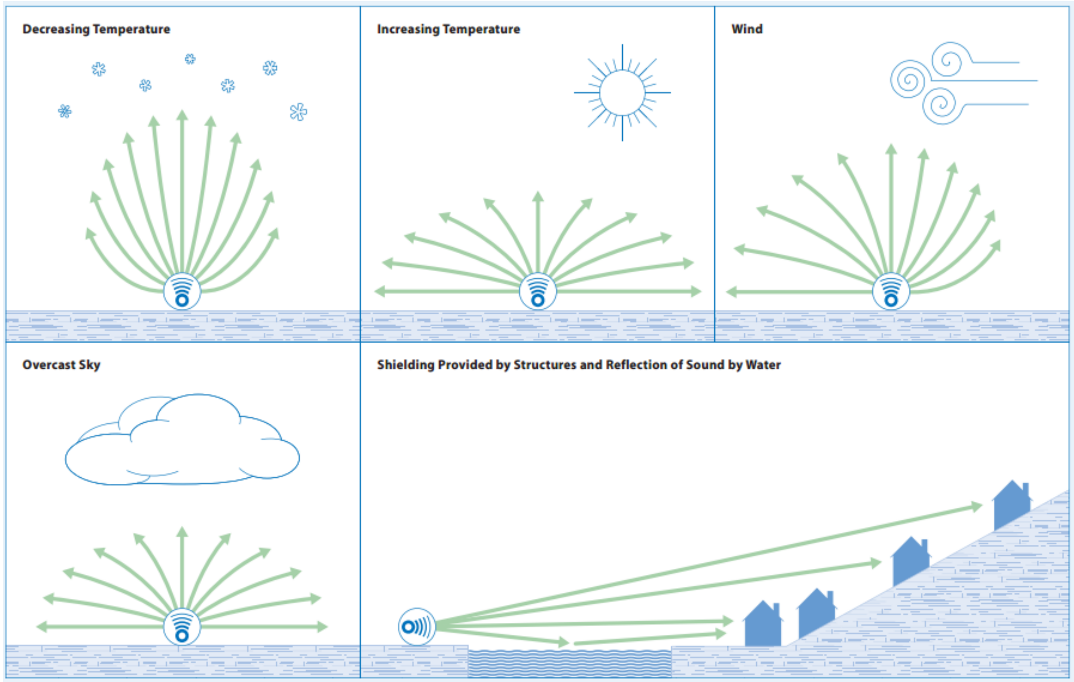

Fig. 7.5 Effect of weather on sound[79]

[79] Oakland International Airport Master Plan Update (2006)

SOUND DISPERSION OVER WATER

An aspect that is more specific to BBTCA is the effect associated with sound reflecting across a water surface. Research shows that this effect has an even more profound effect than weather occurrences. The perception that sounds are noisier when travelling over water can be explained by two physical principles: Refraction and Reflection.

Refraction involves a bending of the sound wave that strikes a material in which it travels slower. Since the temperature of the water in a bay is usually cooler than the normal air temperature, the air just above the water level is cooled by the water. The temperature varies according to the distance from the surface of the water. This gradient of speeds results in a lens effect due to refraction of sound, which tends to focus and thus increase its apparent loudness.[80]

Furthermore, water acts as a hard acoustical surface that enhances the **reflection** of the sound resulting in increased annoyance compared to a situation where sound would be absorbed by a soft ground surface such as a grassy field. If the water is smooth or calm, the sound waves skim the surface of the water and are reflected toward the observer, adding to the amplification. However, if the water is choppy, the sound is randomly reflected and makes no contribution to the amplitude of the sound.[81]

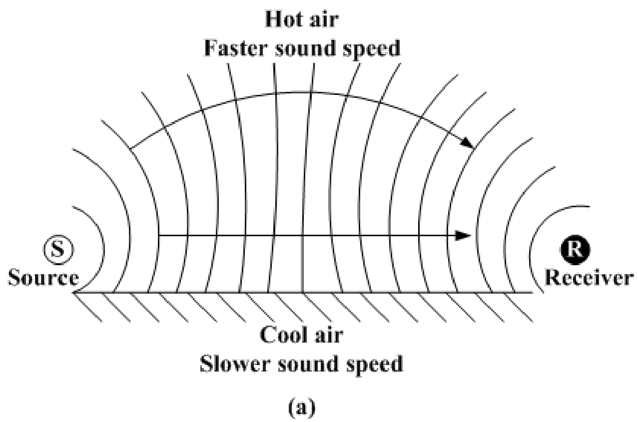

Fig 7.6 Noise Refraction

[80] http://hyperphysics.phy-astr.gsu.edu/hbase/sound/refrac.html
[81] http://hyperphysics.phy-astr.gsu.edu/hbase/sound/reflec.html

These findings are difficult to specifically discuss in the context of BBTCA, within the urban context where expressways, roadways, high rise buildings and other hard surfaces contribute to the complexity of noise propagation in the vicinity of the airport.

TRANSPARENT DISCLOSURE OF AIRCRAFT NOISE

As the material covered in this section indicates, noise is highly subjective and perception can be affected by a range of environmental, man-made and individual factors. Because of this complex environment, the best option remains the use of transparent tools to describe aircraft noise. Transparent means delivering the message in an everyday language and in such a way that can be verified by the layperson. Transparency can also mean empowering individuals by providing them with the appropriate information in order to allow them to make their own view on acceptability of current and future aircraft noise.[82]

One of the most broadly accepted tools worldwide for disclosure of aircraft noise is a real-time web-based application providing information on aircraft movements and associated noise events. WebTrak is such a tool and has been implemented successfully at the Vancouver International Airport (http://webtrak.bksv.com/yvr).[83]

WEBTRAK

WebTrak is a web-based tool that allows the user to view "real-time" and historical flight and noise data collected by the Airport Authority's Aircraft Noise Monitoring & Flight Tracking System. Such a system provides a high degree of transparency and offers an interactive means to manage noise complaints.
Toronto-Pearson is projecting a roll-out of WebTrak in 2013 and this will cover the Greater Toronto Area, including traffic to other airports such as BBTCA. It is understood that BBTCA has access to the same monitoring platform as the GTAA which would allow implementation of a web-based tool such as WebTrak.

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[82] Expanding Ways to Describe and Assess Aircraft Noise, Infrastructure Australia, 2000
[83] http://www.wired.com/autopia/2009/05/aircraft-noise-tracking-website-is-music-to-residents-ears/

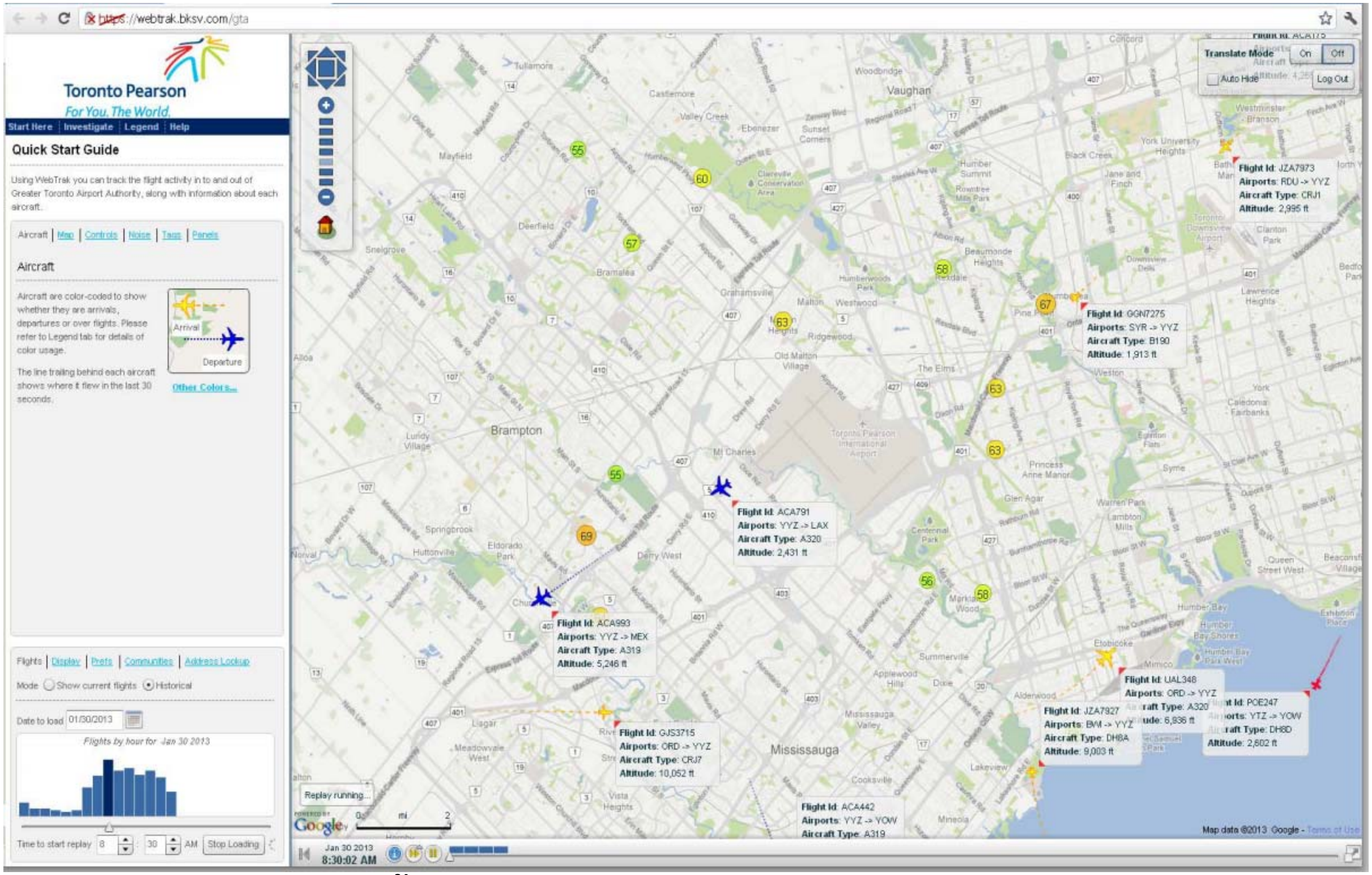


Fig 7.7 Toronto-Pearson Webtrak - demo[84]

[84] http://www.torontopearson.com/uploadedFiles/Pearson/Content/Your_Airport/Noise_Management/2013-02-

AIRCRAFT NOISE CERTIFICATION

The EPNdB(Effective Perceived Noise in Decibels) metric is used in the certification of most jet and heavy turboprop aircraft. It assesses the true noisiness of a complete aircraft event, considering spectral characteristics, tonal content and persistence of the sound. It cannot be directly measured but is calculated using a standard defined by the International Civil Aviation Organisation (ICAO).

The Standard and Recommended Practices (SARPs) of ICAO are contained in 18 annexes to the 1947 Chicago Convention on International Civil Aviation[85] to which Canada is a party. Part 1 of Annex 16 (Environmental Protection -- Aircraft Noise) defines the SARPs relating to Noise Standards. Moreover, Chapter 516 of Transport Canada's Canadian Aviation Regulations incorporates these ICAO noise standards by reference[86].

Annex 16 defines the noise limits for the purpose of certification as well as references and their test procedures. A standardized methodology is used which involves measurements at three (3) specific points of an aircraft's journey:

- Lateral / Full-Power

At a point on a line parallel to and 450 m from the runway centre line, where the noise level is a maximum during take-off.

- Approach

  At a point on the ground, on the extended centre line of the runway 2km from the threshold. On level ground this corresponds to a position 120 m (394 ft) vertically below the 3° descent path originating from a point 300 m beyond the threshold.

- Flyover

At a point on extended centre line of the runway and at a distance of 6.5 km from the start of roll.

06_WebTrakPresentation.pdf

[85] http://www.icao.int/publications/pages/doc7300.aspx

[86] http://www.tc.gc.ca/eng/civilaviation/regserv/cars/part5-standards-chapter516-1926.htm

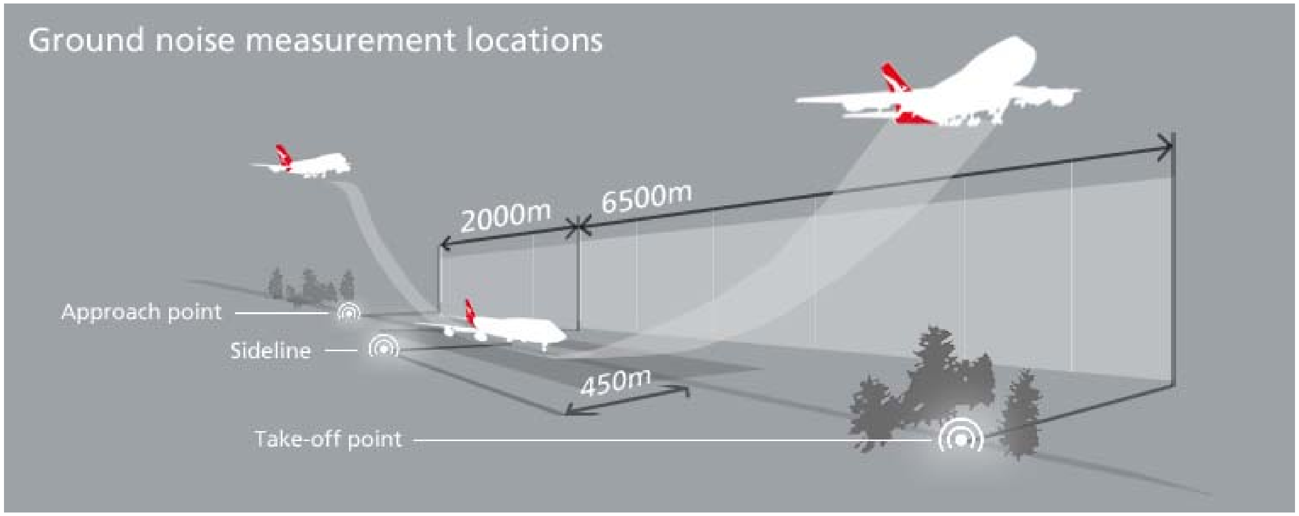


Fig 7.8 Ground Noise Measurement Locations (source: Qantas)

Maximum noise levels under Annex 16 have been applicable since 1972 through Chapter 2 requirements. The maximum levels vary depending on the Maximum Certified Take-Off Weight of a given aircraft. New quieter noise standards (Chapter 3 of Annex 16) were introduced in 1977 for new aircraft models and in 1981 for derivatives of existing aircraft. The key features of these new standards included reduction of limits by 16 EPNdB for light aeroplanes and 10 EPNdB for heavy aeroplanes (based on the sum of three (3) certification measures - lateral, approach, and flyover).

Chapter 4 standards of Annex 16 for new jets was accepted in 2001 for application in 2006. These required a cumulative (sum of margins at all three measurement locations) reduction of 10 EPNdB compared to Chapter 3.

In Canada, under Federal Legislation[87], Chapter 2 aircraft were phased out by 2002 (exceptions involve aircraft operating to parts of Northern Canada). Some of the most common Chapter 2 aircraft were the B737 classic and B727, although these types do remain in operation at major airports in Canada due to the use of hush-kits installed on engine exhaust to reduce noise levels and ensure their compliance to Chapter 3 noise standards.

[87] Part V - Airworthiness Manual Chapter 516 - Aircraft Emissions of the Canadian Aviation Regulations (CARs)

In February 2013, the International Civil Aviation Organization's (ICAO) Committee on Aviation Environmental Protection (CAEP) met for its ninth formal meeting (CAEP 9) in Montreal. An outcome of this meeting was a recommendation that ICAO adopt a new, more stringent aircraft noise certification regime for new aircraft designs.

The agreed upon new noise standard (Chapter 14 of Annex 16 Volume I) will be a cumulative 7EPNdB below ICAO's current Chapter 4 standards and will be applicable to new-design aircraft entering into service from 2017 for aircraft greater than 55 tonnes and from 2020 for aircraft under 55 tonnes.

TRIPARTITE AGREEMENT

Under clause 14 (1)e of the Tripartite Agreement, the lessee (Toronto Port Authority) shall not permit aircraft generating excessive noise to operate to and from BBTCA, with the exception of medical evacuations, other emergency use required, and during the period of the annual Canadian National Exhibition airshow.

Clause 14 (2) provides the definition of an aircraft generating excessive noise based on the type and weight of the aircraft. Commercial airliners such as the Dash8-Q400 (propeller-driven over 5,700kg) would be deemed to generate excessive noise if they generate a noise level in excess of 84.0 EPNdB on takeoff (flyover), or in excess of 83.5 EPNdB on sideline at takeoff (lateral to the flight path) or in excess of 92.0 EPNdB on approach. However, under Section 5.5 of Annex 16 Volume I, trade-offs are allowed where one or two measurements exceed the limit as long as the sum of excesses is not greater than 3 EPNdB, any excess at any single point is not greater than 2 EPNDB and that any excesses are offset by corresponding reductions at the other point or points.

The following chart presents the evolution of international noise certification standards in comparison to the rules set in the 1983 Tripartite Agreement. The chart addresses a range of existing turboprop and narrowbody jet aircraft, as well as the advised cumulative noise level for the CS100.

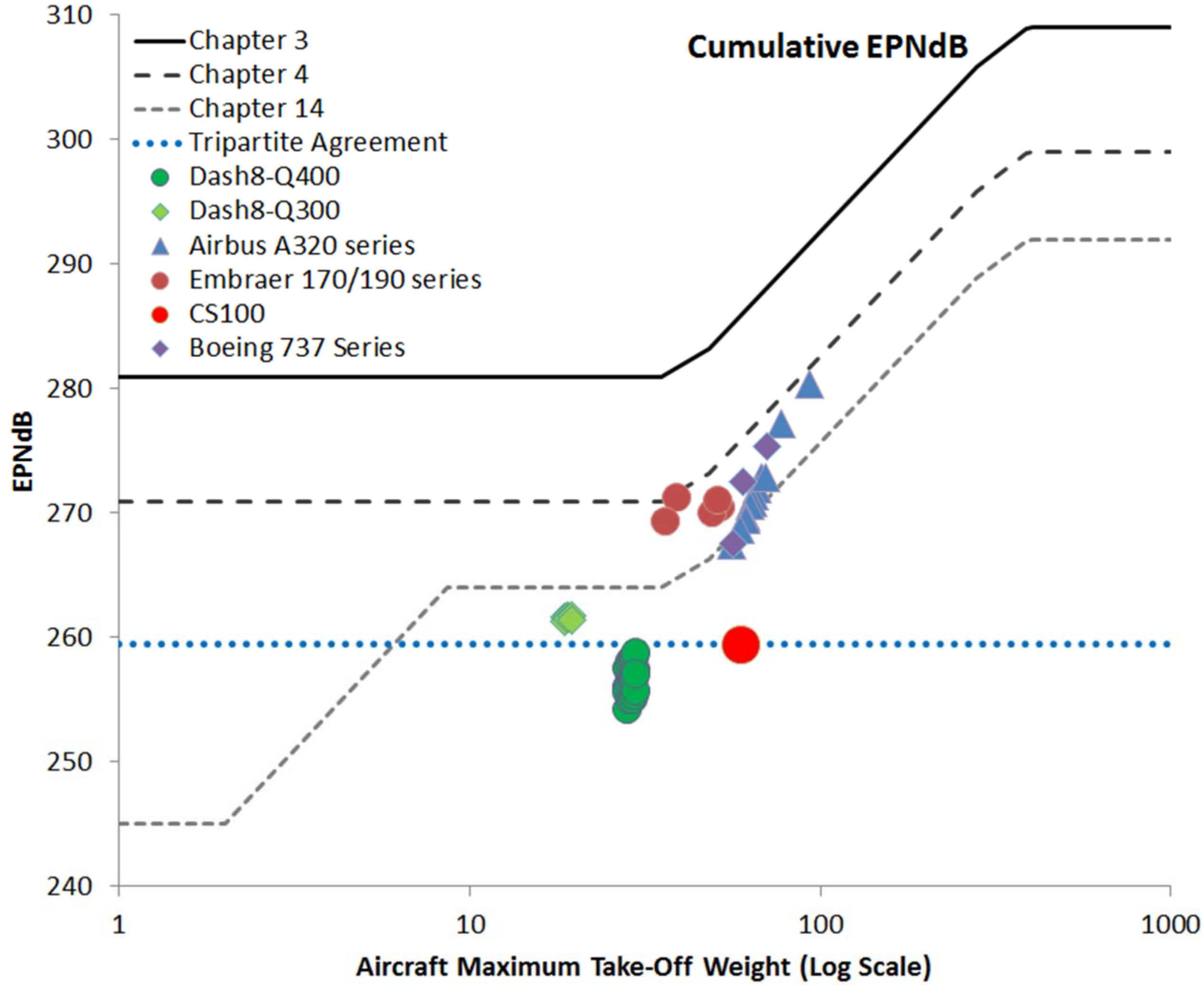


Fig 7.9 Cumulative EPNdB / Noise Certification Standards and Aircraft Compliance

The cumulative noise level requirements described in the Tripartite Agreement (259.5 EPNdB) are within restrictions set in the ICAO's Annex 16 Chapter 14 standards. For a 2-engine aircraft of the weight of the

Dash8-Q400 this will require a cumulative noise level of 264 EPNdB once formally adopted by ICAO. However, the noise level requirements contained in the Tripartite Agreement are less stringent than the requirements found in the forthcoming Chapter 14 standards for light jet aircraft (under 8.6 tonnes) that will enter service by 2020. Based on very light jets (VLJ) currently operating in the market such as the Embraer Phenom 100, the Eclipse 500 and the Cessna Mustang 510, this new standard merely matches what is already being achieved by these relatively quiet aircraft.

Formal confirmation of the CS100 compliance to the Tripartite Agreement also requires the certification of the noise levels at each measurement points (Approach, Lateral and Flyover) which will not be completed until May 2014 (based on advice received from Porter Airlines). The methodology outlined in Chapter 5 of ICAO's Annex 16 states that in the event that the maximum noise levels are exceeded at one or two measurement points:

a) The sum of excesses shall not be greater than 3 EPNdB;

b) Any excess at any single point shall not be greater than 2 EPNdB; and

c) Any excesses shall be offset by corresponding reductions at the other point or points.

Bombardier has previously guaranteed that it would meet the cumulative levels. The information disclosed at this stage of the testing process for the Bombardier CS100 is trending in line with previous information and statements made by Bombardier. However, formal confirmation of the compliance of the CS100 to the Tripartite Agreement individual noise limits will only occur at the outcome of the certification process which is presently expected to occur in May 2014.

NOISE EXPOSURE

Noise exposure is the accumulation of aircraft operations and their associated sound energy levels. Metrics such as the NEF (Noise Exposure Forecasts) used in Canada represent noise exposure with a single number rating of overall aircraft noise. These are then correlated to land use zoning criteria (noise-dose-response curves which are correlated to societal, as opposed to individual response to aircraft noise). There are a number of metrics used by various countries, but all include a weighting for operations at night or in the evening, in recognition of increased sensitivity for sleep disturbance at this time. The software NEF-CALC (Version 2.0.6.1 being the most recent) is used for modelling noise exposure contours in Canada.[88]

[88] http://www.tc.gc.ca/eng/civilaviation/standards/aerodromeairnav-standards-noise-nef-924.htm

The Tripartite Agreement states that the lessee (Toronto Port Authority) must regulate the overall frequency of aircraft movements in order to contain the actual 28 NEF Contour within the boundary of the official 25 NEF Contour for 1990 illustrated below except in a westerly direction beyond the official 25 NEF Contour at any point between the two points marked " X and "Y" on the official 25 NEF Contour in the image below. The cap of 202 movements on commercial operations is imposed by the TPA as a means to ensure that this condition set in the Tripartite Agreement is not breached.

Fig 7.10 Tripartite Agreement – Noise Exposure Forecasts (1990)

Recent noise studies commissioned by Transport Canada as part of its responsabilities under the Tripartite Agreement have confirmed compliance of existing operations to the 1990 NEF noise exposure forecasts defined in the Tripartite Agreement. The following table and charts provide key outputs from the analysis for 2008 and 2010.

	Total Movements	Total Itinerant Movements	Total Local Movements	Helicopters	Night Movements
2008	464.6	214.4	250.2	n/a	2.8%
2010	627.0	384.0	218.0	25.0	2.9%

Table 7.1 Annual Noise Studies – Summary Table

Note that there were helicopter movements in 2008 but as per the Tripartite Agreement these were not modelled because they were not required to adhere to specific flight tracks. Helicopter movements were modelled in 2010 because of the need to fly specific flight tracks.

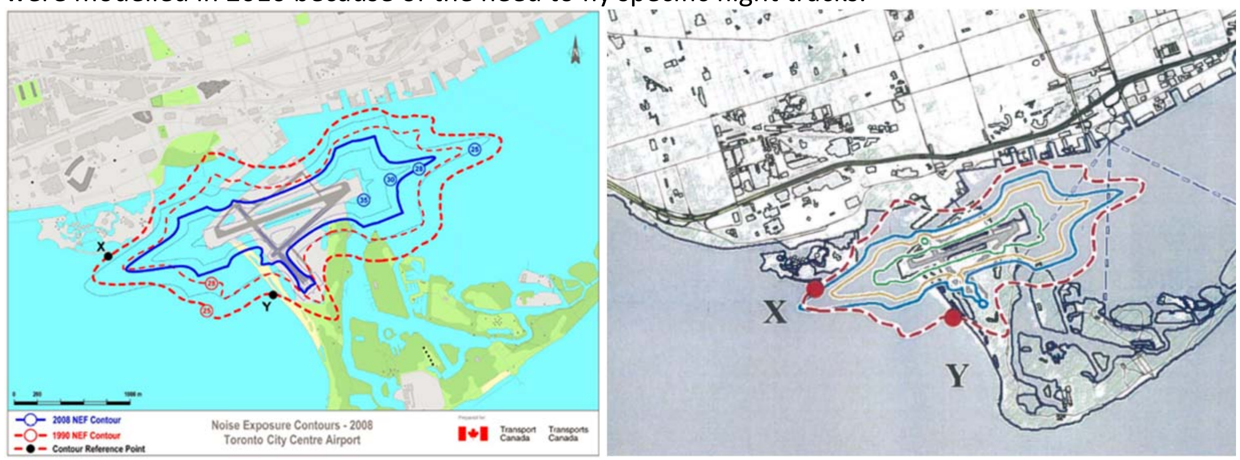


Fig 7.11 2008 / 2010 Annual Noise Studies – Tripartite Agreement Compliance

At present it is not possible to reliably assess the impact of the CS100 aircraft on its compliance to the contours described in Schedule A of the Tripartite Agreement. Once the CS100 sound levels are certified, Transport Canada would need to update the database of its noise modelling software, or advise a suitable substitution (as it is currently done with the Dash8-Q400 which uses the Dash8-Q300 as a surrogate) to enable a reliable review. The US Federal Aviation Administration (FAA) has advised that the ERJ170-100 (Embraer 170), an aircraft added to the US Integrated Noise Model database in May 2013, should be used as a substitute for the CS100 for the time being. However, this aircraft model is not available in Transport Canada NEF-CALC software. Furthermore, as the CS100 uses new engine technology, the use of a surrogate may not provide the same level of accuracy as aircraft-specific modelling data would. The decision to proceed with a substitution or an aircraft-specific dataset will

ultimately be under the purview of Transport Canada.
Until an assessment can be made based on the revised commercial fleet and operational patterns, the current cap of 202 movements is assumed to remain an adequate interpretation of the Tripartite Agreement noise exposure compliance levels, especially as the CS100 is expected to operate at noise levels similar to the Dash8-Q400. However, the proposed modifications to the airfield layout may impact the noise contours because the start of the take-off roll of the CS100 and comparable jet aircraft would be displaced compared to the existing airfield.

SURROGATE NOISE PROFILE

The CS100 is still in testing phase and as such, the aircraft noise modelling parameters have not been developed yet. For the purpose of the Health Impact Study, Airbiz was tasked with the development of a surrogate noise profile for the purpose of representing potential jet aircraft activity at BBTCA.
Generally, a substitute aircraft would be found to represent the actual aircraft type. However, when this aircraft contributes a significant proportion of the total noise, aircraft selected on the basis of this criterion are unlikely to have sufficiently similar noise footprints to those they are substituting for. Under these conditions the ECAC (European Civil Aviation Conference) recommends selecting as a proxy the listed aircraft with the closest weight, same number of engines and installed thrust-to-weight ratio to the unlisted aircraft.[89]
The proxy aircraft should preferably be from the same manufacturer as the unlisted aircraft although it is accepted that this will not be possible in all cases. Powerplant differences can be taken into account subsequently by applying adjustments based on certified noise levels. The ECAC suggest making the adjustments under the form of equivalent numbers of operations. The UK CAA suggests a similar adjustment directly to the NPD (Noise Power Distance) levels of the proxy aircraft.[90] The noise model data is adjusted based on differences between the projected certification data and the surrogate aircraft's known data.

Separate adjustments should be made for arrivals and for departures. For arrivals, the difference will be assessed based on the approach certification noise levels. For departures, the difference between the

[89] ECAC Doc 29 – Report on Standard Noise Method of Computing Noise Contours around Civil Airports.
[90] ERCD Report 0705 – Revised Future Aircraft Noise Exposure Estimates for Heathrow Airport.

arithmetic averages of the certified lateral and flyover levels.

Bombardier has suggested that the Boeing 737-700 should be used as a baseline surrogate for the CS100. The CRJ900, a Bombardier manufactured aircraft was reviewed but deemed inappropriate as a surrogate due to the location of the engines on the fuselage as opposed to the wings.

TRIPARTITE AGREEMENT ADJUSTED AIRCRAFT NOISE LEVELS

Bombardier has indicated that the CS100 will meet the cumulative noise levels set in the Tripartite Agreement but, the CS100 has yet to be certified. Based on this, a decision has been made by the City and agreed with by Bombardier to develop a Tripartite Agreement compliant jet aircraft model based on the Tripartite Agreement Noise Limits so that it could represent all jet aircraft that may have the ability to operate at BBTCA. The following table highlights the certification noise levels of the proposed proxy aircraft against the Tripartite Agreement.

Proxy Aircraft	Engine	MTOW (kg)		Approach	Sideline	Flyover
Tripartite Agreement			Noise Limits	92.0	83.5	84.0
B737-700	CF567B	70,080	Certification	96.1	93	85.9
			Adjustment	4.1	9.5	1.9

Table 7.2 Surrogate Aircraft Adjusted Noise Levels

The NPD (Noise Power Distance) curves for the Boeing 737-700 have been modified based on the adjustments required to match the certification noise requirements. This methodology and proposed adjusted NPD curves should be reviewed by Transport Canada to ensure their agreement with the methodology used.

ENGINE RUN-UPS

As part of the regular inspection and maintenance of aircraft, aircraft engines require testing at high power levels to ensure their proper operation and the safety of operations. While necessary, engine run-up operations can be a disturbance to surrounding communities, especially when conducted at night.

Furthermore, while these operations are a common occurrence at airports, they are not required by Transport Canada to be included in the assessment of noise contours, which means that run-up operations are not a contributing factor that is assessed for compliance to the limits set in the Tripartite Agreement.

In a 2010 Noise Management Study, it was recommended that the TPA should "assess the potential of implementing noise control barriers at or near any proposed aircraft engine run-up areas or pad." An environmental assessment screening report was produced in 2011 which subsequently led to the construction of a single 6m high by 82m long acoustic barrier near Runway 15. This is anticipated to reduce noise by 10 dBA up to five storeys high. An additional noise barrier east of the terminal building and an engine run-up enclosure was also included in the environmental assessment screening report. These have not yet been built.[91]

The first engine run-up enclosure in Canada was commissioned in 2012 at the Vancouver International Airport. At 67m wide by 80m long and varying in height between 11 and 15m, this enclosure was built at a cost of approximately $12 million and was expected to be utilized primarily by smaller planes in the southern precinct of the airport as this area is located closer to nearby communities. The project was featured on the Discovery Channel in February 2012.[92]

Noise reductions for engine run-ups within the Vancouver Airport enclosure were calculated to be on average 15 dB although some residential areas did experience more significant reduction than others. It remains important to manage expectations when commissioning such a facility especially in the context of the BBTCA where many high-rises are located in close proximity to the airport and apartments on upper floors are less likely to see the benefits of such an installation.

[91] Noise Barriers and Engine Groud Run-Up Enclosure Environmental Screening Report, CPA EA Regs, October 2011
[92] http://watch.discoverychannel.ca/#clip615146

EXISTING AND PROJECTED RUN-UP OPERATIONS

Existing engine run-up information was provided by Porter Airlines for the Dash8-Q400. It highlighted that a total of 60 engine run-ups were conducted in the 12 months between October 2012 and September 2013 specifically for the following tests:

- Engine Change 17 events
- Propeller Pitch Control Unit 9 events
- Propeller Electronic Control 6 events
- Propeller Assembly 26 events
- Fuel Metering Unit 2 events

The nature of the engine run-up will vary depending on the maintenance activity conducted. All activities were undertaken on Runway 33, between 6:45am and 11:00pm[93].

For the CSeries, Pratt & Whitney has provided guidance on the expected frequency of CS100 engine run-ups. This information is based solely on Porter Airlines' proposal and does not consider other potential operations. Pratt & Whitney advised that for engine maintenance up to and including full engine change, their manuals will require no high-power ground running except for the following activities:

- Vibration Survey
- Troubleshooting
- Other Unscheduled Maintenance

Based on a potential inaugural fleet of 12 CS100 aircraft, Pratt & Whitney has indicated a conservative estimate of approximately 5 high-power engine run-ups per year.[94]

[93] Porter Airlines
[94] Pratt & Whitney

08. GENERAL AVIATION CONSIDERATIONS

General Aviation is a sizeable component of traffic at BBTCA. Over 50% of the total aircraft movement traffic is generated by general aviation aircraft. Of this general aviation activity, a majority of movements is conducted locally (flights that remain in the vicinity of the airport or take-off and land from BBTCA). This section reviews the potential impacts of the Porter Airlines proposal on general aviation activities.

INFRASTRUCTURE AND CAPACITY

The proposed runway lengthening of Runway 08-26 will not directly affect general aviation operations. The integrity of the two cross-runways is maintained which will enable small aircraft operators to retain access to runways providing optimal crosswind coverage.

If the lengthening of Runway 08-26 is not associated with taxiway improvements, aircraft requiring the full runway length will be required to backtrack prior to proceeding with a take-off roll which may result in a reduction in the runway capacity. However, most general aviation aircraft may not require the full length of the runway and would have the ability to conduct intersection departures which will expedite operations.

On the aprons, the parking of CS100 aircraft on the Eastern and Western side of the passenger terminal will increase spatial constraints, but it appears from initial planning documents to have little or no impact on the current GA operation. Plans to increase the footprint of the passenger terminal building could over time add constraints on general aviation airside activities. This will be subject to the review and approval of the final aircraft parking plans, a review of pushback and ramp operations proposed by Porter Airlines.

NOISE EXPOSURE CONTOURS CONSIDERATIONS

The quantity of operations at BBTCA are guided by a compliance process of existing operations to the NEF Noise Exposure Forecasts 1990 as contained in Schedule A of the Tripartite Agreement.

A review conducted in 2010 concluded that suitable busy day general aviation provisions had been included in the scenario that led to the development of the 202 daily commercial operations scenarios as follows: [95]

- 147 Daily Itinerant General Aviation Movements (modelled with a mix of generic single piston, twin piston and twin turboprop aircraft);
- 236.9 Daily Local General Aviation Movements (modelled with a mix of generic single piston and twin piston aircraft); and
- 4.4% of itinerant movements assumed to be operating at night-time (i.e. between 10pm and 7am).

GENERAL AVIATION JET OPERATIONS

Under a scenario where all jet operations compliant with the Tripartite Agreement noise levels are allowed to operate at BBTCA, a lift of the ban on jet operations would immediately allow small general aviation jet aircraft such as Very Light Jets (VLJ) to operate from the existing runway. The impacts of such a change have not been specifically assessed and would depend on the demand for very light jet services, availability of parking and the provision of services dedicated to VLJs. Figure 8.1 presents the cumulative noise levels of these aircraft in comparison to the CS100, the Dash8-Q400, the Tripartite Agreement noise limits and other international noise standards.

This graphic highlights that small general aviation jets are quieter than the CS100 and Dash8-Q400. As such, a total lift on the ban of jet aircraft could create new opportunities for general aviation operators at BBTCA.

General Aviation activities were found to be generally unaffected by the Porter Airlines proposal. This does not mean that GA activity is not changing at the BBTCA. Recent discussions between the Canadian Owners and Pilots Association (COPA) and HLT Consultants indicated a desire on the part of the COPA group to see a Master Plan for BBTCA in the near future to address the changes at the airport and to provide the GA users with a long term vision. The TPA confirmed that the Master Plan process will not proceed until there has been a resolution to the proposal by Porter Airlines.

The review within this report focuses on the impact to GA from the Porter Airlines proposal itself and does not address the broader trends or long term planning requirements of the GA community.

The most recent review of the commercial aircraft movements slot allocation assumed over 380 general aviation movements on a busy day. The runway extension proposal does not limit the range of GA

[95] Noise Management Study – Interim Report, February 2010, Jacobs Consultancy

aircraft that can operate at BBTCA. Additional spatial constraints may occur on aprons as a result of the categorization of Runway 08-26 as category 3 runway. This will increase the clearances laterally from the runway and from the space required for parking the CS100 or similar aircraft.

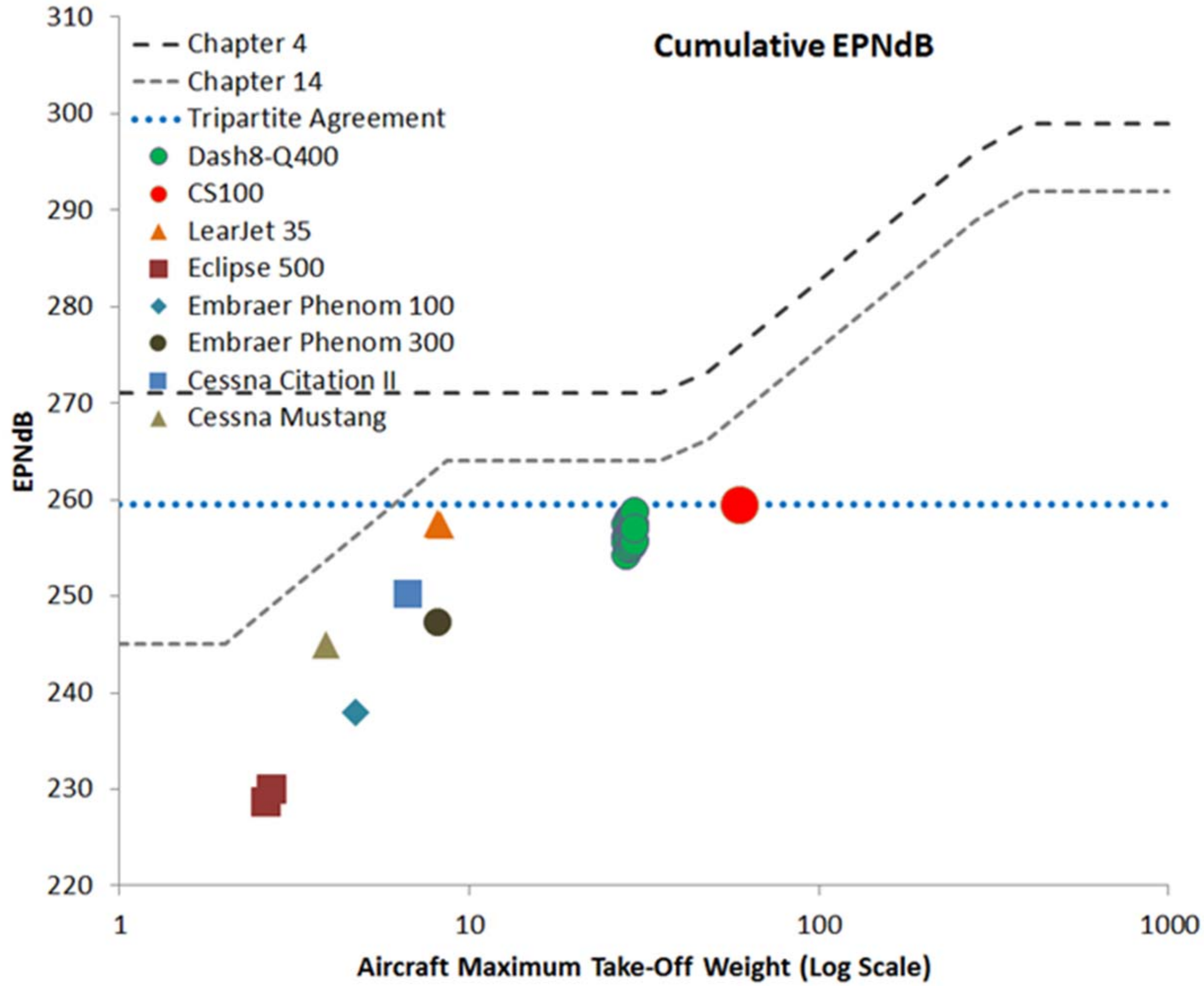


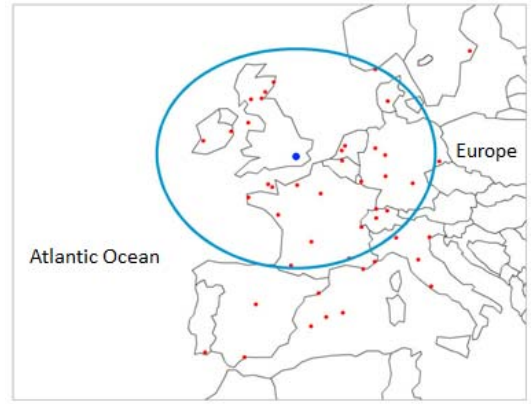
Fig 8.1 Cumulative EPNdB / Noise Certification Standards and Aircraft Compliance

09. CASE STUDIES – WATERFRONT/URBAN AIRPORTS

This section discusses examples of airports currently operating within an urban and/or waterfront area around the world in a manner similar to BBTCA. Benefits, constraints and impacts are described. Comparable examples of waterfront airports around the world include the London City Airport (United Kingdom) and the George Best Belfast City Airport (Ireland). Other significant urban airports include the Bromma-Stockholm Airport (Sweden).

Fig 9.1 Location of Airports Investigated as Case Studies

LONDON CITY AIRPORT, UNITED KINGDOM



London City Airport is built on the former Royal Docks with a 1,508m long runway but with a take-off length of 1,199m and landing length of 1,319m. It operates under several restrictions including a curfew on operations between 12:30pm on Saturday and 12:30pm on Sunday.

It was formally opened in 1987 as a STOLport (Short Take-Off and Landing Port) with a condition that limits operations to the Dash-7 aircraft or equivalent (7.5 degrees approaches), with a limit of 120 movements per day (40 on weekends) and hours of operations restricted to 630am to 1000pm (900am to 1000pm on Sundays and public holidays). Helicopter movements were prohibited.

In 1992, the runway was extended to 1,508m[96] and the approach slope reduced to 5.5 degrees to cater to larger aircraft including the BAE146 4-engined jet aircraft and the Dash8. Furthermore, a daily movement cap was increased to 130 daily movements on weekdays and 80 daily movements on weekends. The annual movement limit went from 30,160 to 36,500.

In 1998, further permission was granted to increase annual movements to 73,000, with 240 daily movements on weekdays and 120 daily movements on weekends (220 movements maximum for the total weekend). Restrictions on operations between 12:30pm on Saturday and 12:30pm on Sunday were also introduced.

In 2005, the DLR (Docklands Light Railway) was commissioned with a station integrated to the airport terminal.

In 2009, the airport was given permission to raise the limit on the number of flights to the current limit of 120,000 annual movements with a maximum of 592 daily movements on weekdays. A travel plan was also developed to encourage passengers and staff to use sustainable transport modes, therefore minimising single occupancy vehicles use to/from the airport.

Routes available from London City Airport cover most of central Europe and are within a 500 nm range.

[96] London City Airport Consultative Committee (LCACC) website - Airport History

The following charts outline the historical traffic at the London City Airport and the relative footprint of the airport in comparison to BBTCA.

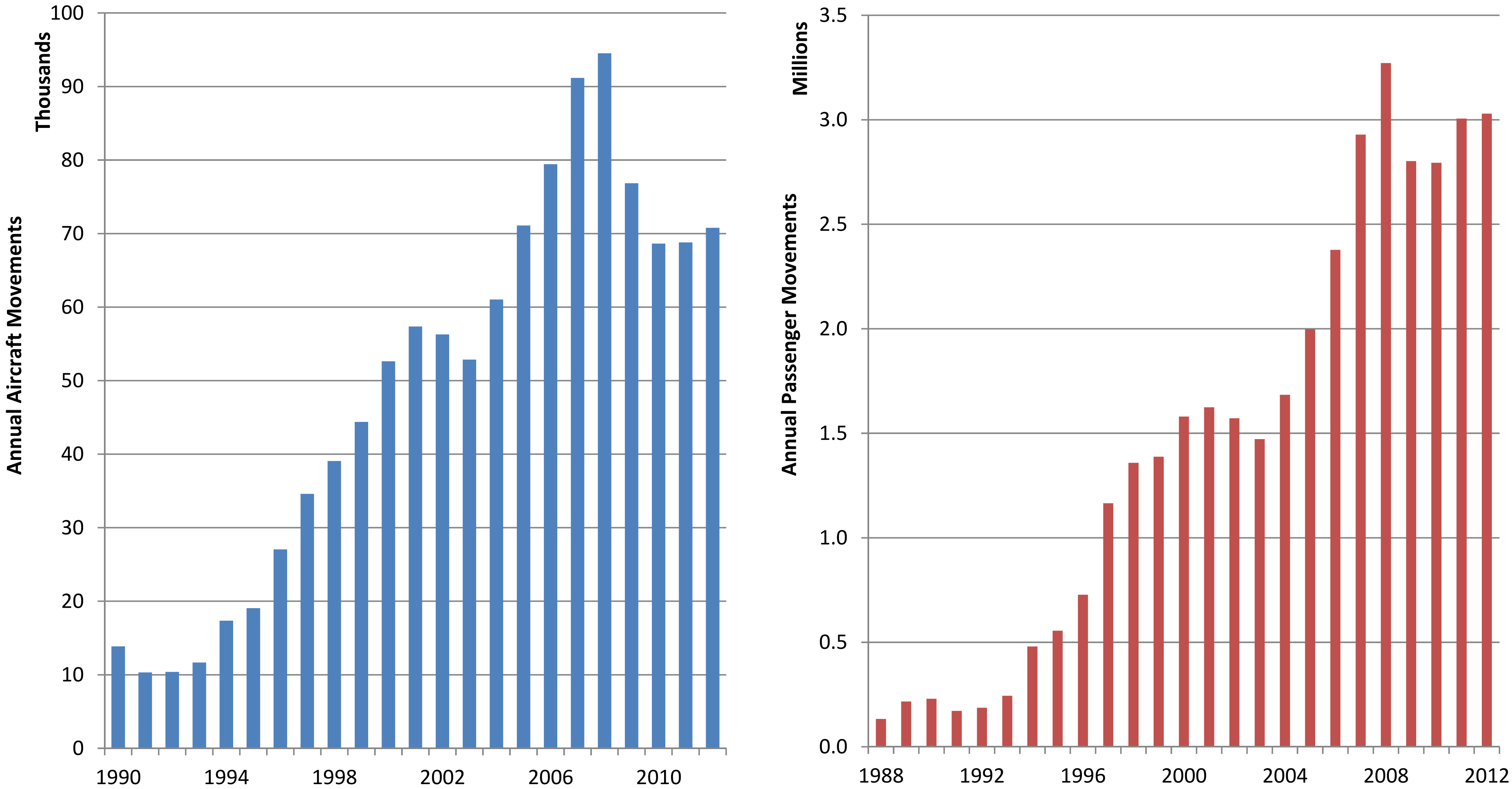


Fig 9.2 London City Airport (LCY) Airport Annual Aircraft and Passenger Movements

Fig 9.3 London City Airport (LCY) Airport Overlay

At London City Airport, aircraft noise is taken into account when calculating the annual movements. Aircraft are categorised and assigned a movement value based on each category as follows:

Category	Movement Value	Noise Reference Level	Aircraft Types
A	1.26	91.6-94.5	Airbus 318, BAe 146, Avro RJ85, Embraer 170, Embraer 190, Fokker 70, Dornier 328 Jet, DHC 6
B	0.63	88.6-91.5	ATR42,F50, DHC-8, Do-328, SF340
C	0.31	85.6-88.5	SAAB2000, S360
D	0.16	82.6-85.5	Do-228, DHC-7
E	0.08	Less than 82.6	-

Table 9.1 London City Airport – Noise Category

The following table presents a week of operations based on 20-26 May 2013 at the London City Airport. It also indicates the noise category of the aircraft currently operating.

Aircraft	Engine	MTOW (tonnes)	Movements	Noise Category
Airbus A318	Jet	59	20	A
Embraer 190	Jet	52	336	A
Avro RJ100	Jet	45	155	A
Avro RJ85	Jet	44	202	A
BAe 146-200	Jet	42	12	A
Embraer 170	Jet	39	173	A
Dash8-Q400	Turboprop	29	58	B
Saab 2000	Turboprop	23	36	C
Fokker 50	Turboprop	21	276	B
ATR42	Turboprop	19	33	B
Dornier 328	Turboprop	14	108	B
TOTAL			**1409**	
AVG DAILY			**201**	

Table 9.2 London City Airport - Weekly Commercial Movements – 20 May 2013 Schedule

CityJet and BA CityFlyer airlines are the main carriers at London City Airport with 32% and 40% of the seats respectively[97]. BA CityFlyer has 6 Embraer E-170s and 7 Embraer E-190s in its fleet[98]. CityJet's fleet consist of 23 Avro RJ85 Avroliner aircraft, 15 Fokker 50 aircraft and 2 Fairchild Dornier Do-328 aircraft[99]. There are a number of constraints existing at London City Airport which are summarised in the Key Operational Specifications table below. These movement restrictions involve; the type of day, hours of specific days, and type of aircraft.

Specifications	Value
Number of Runways / Length	1(1508m)
Glide Slope	5.5 degrees or steeper[100]
Distance from Downtown	11 km[101]
Annual Aircraft/Passenger Movements	111,280 (2011)
Hours of Operations	06:30-22:30 Weekdays 06:30-13:00 Saturday / 12:30-22:30 Sunday
Movement Cap	120,000 Annual Movements 592 on Weekdays (excluding bank holidays etc) 100 Saturday / 200 Sunday / 280 Combined Weekend Additional Restrictions
Noise Cap	Movements weighted through noise category assessment

Table 9.3 Key Operational Specifications – London City Airport

London City Airport is connected to the city through public transport. The Docklands Light Railway (DLR) stops at the airport, and provides transportation to the city as well as connections to the London Underground network and rail network through Canning Town. 51% of the passengers commuting to and from London City Airport use the DLR[102]. A number of local bus routes pass through the airport

[97] SABRE (20-26 May 2013 schedules)
[98] British Airways website – Fleet Facts
[99] CityJet website – Our fleet
[100] Boeing Noise Information – London City Airport
[101] NATS Document
[102] London City Airport website – Visiting the Airport http://www.londoncityairport.com/visitingtheairport/GettingHere

providing transport to and from the airport in addition of personal cars and taxis.
The following table describes high level benefits and drawbacks associated with the operation of the London City Airport from the point of view of the operator.

Benefits	Drawbacks
• Proximity to downtown • High Modal Split of Train users • Direct train-station access • Simple Noise Category System to assess movement cap	• Significant weekend restrictions on operations • Daily movement caps • Highly constrained groundside area

Table 9.4 Benefits and Drawbacks of London City Airport

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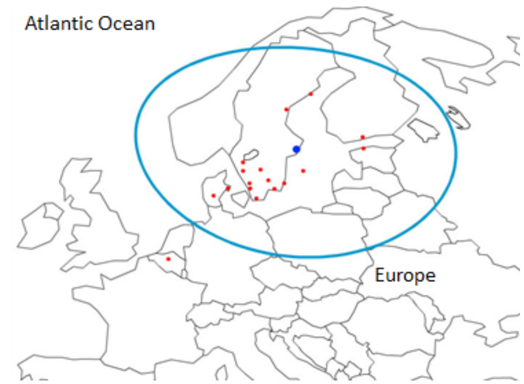
http://www.londoncityairport.com/AboutAndCorporate/page/AirlinePartnersLocationAndTransportation

BROMMA-STOCKHOLM AIRPORT, SWEDEN



The Bromma-Stockholm Airport is an urban airport initially commissioned in 1936 and which like similar airports in an urban environment was unable to cater to the introduction of jet aircraft in the 1960s. This led to the relocation of commercial activities to the new Stockholm-Arlanda Airport, which opened from 1960 to 1962, some 35 kilometres north of Stockholm. Bromma Airport remained opened as a domestic airport until 1983, and then as a general aviation facility until Malmö Aviation launched commercial services in 1992. Located 8 kilometres from Stockholm, it predominantly draws business passengers. Bromma Airport's route map is dominated by Swedish Airports and airports within a range of 500nm. Malmö Aviation currently operates 12 RJ100/RJ85 jet aircraft, but has purchased 5 CS100 and 5 CS300 aircraft with options for additional 10 aircraft. The CS100/300 is a quieter aircraft then the R100/RJ85 ensuring an acceptable replacement. These aircraft will assist Malmö in managing some of the key restrictions that are in place at Bromma Airport. These restrictions include a cap of 20,000 annual movements for aircraft with a seating capacity exceeding 60 seats with a noise emission which exceeds 86 but not 89 EPNdB as an average for the three measuring points in accordance with ICAO Annex 16, Volume I, Part 2, Chapter 3.[103]

Restrictions associated with operations at Bromma-Stockholm Airport include the following:

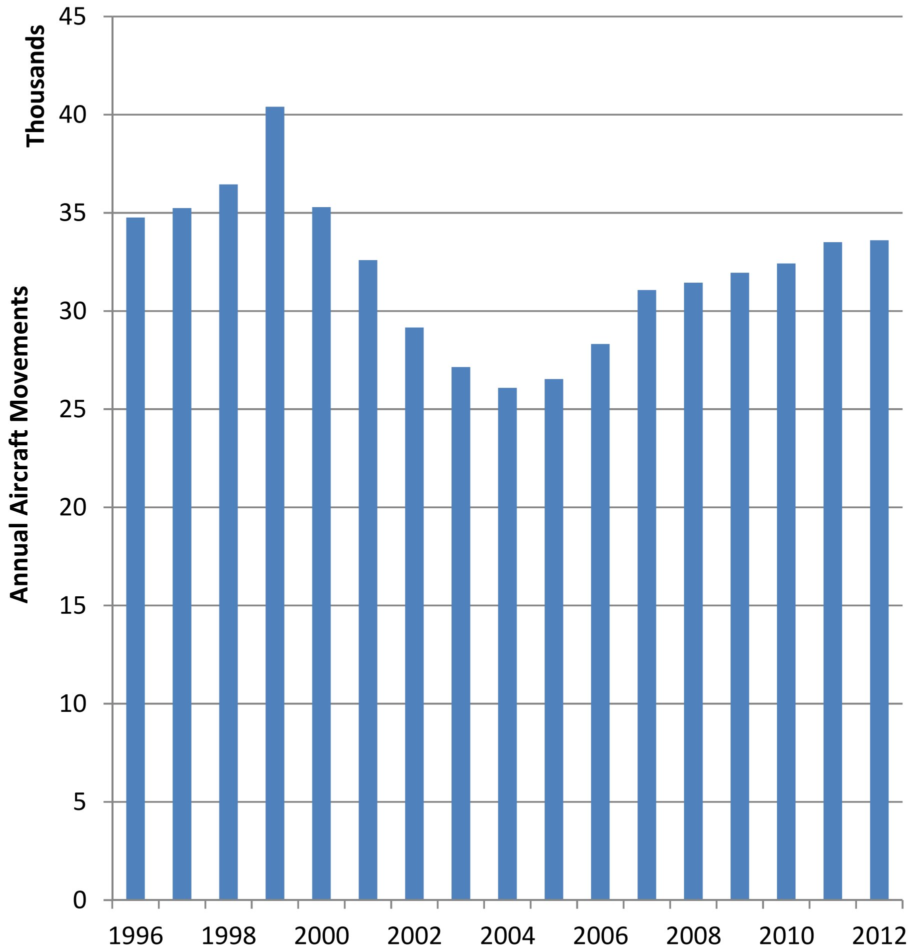
- Check running of engines 2100-0600 may be carried out in connection with take-off only;
- Test running of engines in connection with maintenance may be carried out only during the operational hours of the aerodrome but not later than 2000; and
- When aircraft are landing, reverse thrust more than idle Reverse should not be applied.

In addition, Bromma-Stockholm Airport is subject to strict operating hours from 6am to 9pm on weekdays, 7am to 3pm on Saturdays and 11am to 9pm on Sundays as well as an annual total cap of 80,000 movements. Despite this, the airport has grown to over 2.2 million passengers in 2011 while operating well within the movement cap with less than 46,000 annual movements.

[103] Boeing, Airport Noise and Emissions Regulations

Despite the commissioning of the Arlanda Express from Stockholm-Arlanda Airport in 1999, which reduced the commute to downtown Stockholm to 20 minutes, passenger traffic at Bromma has more than doubled since then, from under 1 million in 1999 to over 2.2 million in 2011. However, it should be noted that both airports are operated by Swedavia, a state-owned company, with Bromma-Stockholm airport scheduled to be handed over to the City of Stockholm in 2039.

The following charts outline the historical traffic at the Bromma-Stockholm Airport and the relative footprint of the airport in comparison to BBTCA.



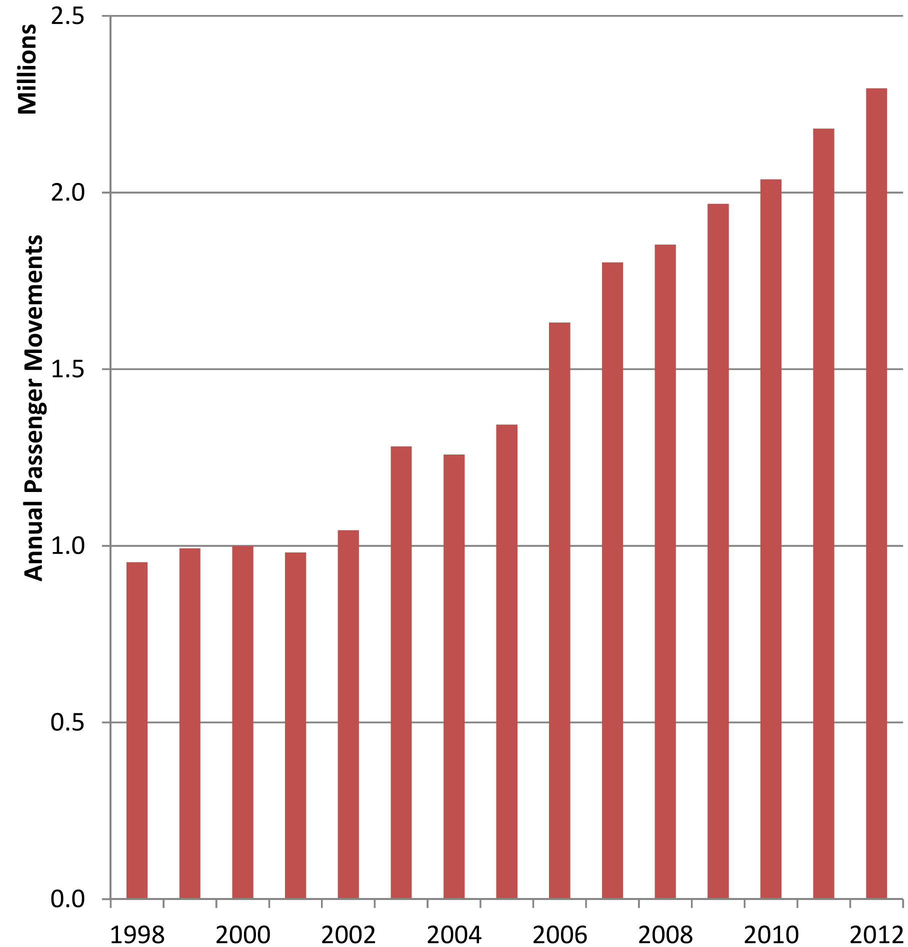


Fig 9.4 Bromma-Stockholm Airport (BMA) Airport Annual Aircraft and Passenger Movements[104]

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[104] Transport Styrelsen – Traffic Statistics Swedish Airports

Fig 9.5 Bromma-Stockholm (BMA) Airport Overlay

The following table presents a week of operations based on 20-26 May 2013 at the Bromma-Stockholm Airport.

Aircraft	Engine	MTOW (tonnes)	Aircraft Movements
Avro RJ100	Jet	45	338
Avro RJ85	Jet	44	64
Dornier 328Jet	Jet	15	14
BAE ATP	Turboprop	23	40
ATR72	Turboprop	23	168
Saab 2000	Jet	23	128
ATR42	Turboprop	19	24
Dornier 328	Turboprop	14	14
Saab 34	Turboprop	12	170
Jetstream 31	Turboprop	7	6
TOTAL			**966**
AVG DAILY			**138**

Table 9.5 Bromma-Stockholm Airport - Weekly Commercial Movements – 20 May 2013 Schedule

Malmö remains the main carrier operating scheduled services at Bromma with over 58% of the seats, followed by Braathens Regional operating under the Sverigeflyg with 24% of the seats.[105]

[105] SABRE (20-26 May 2013 schedules)

There are a number of constraints existing at Bromma-Stockholm Airport which are summarised in the Key Operational Specifications table below.

Specifications	Value
Number of Runways / Length	1 (1,668m / 5,472 ft)
Glide Slope	3.5°
Distance from Downtown	8km
Annual Aircraft/Passenger Movements	46,000 / 2.2 million (2011)
Hours of Operations	Monday to Friday – 6:00 to 21:00 Saturday – 7:00 to 15:00 / Sunday – 11:00 to 21:00
Movement Cap	80,000 Annual (including 20,000 aircraft with more than 60 seats and EPNdB between 86 and 89)
Noise Cap	Must not exceed 89 EPNdB, an average for the three points of measurement in accordance with ICAO

Table 9.6 Key Operational Specifications – Bromma-Stockholm Airport

Bromma airport is approximately 8km from Stockholm City. Passengers have the option of; getting the airport coach to/from the city, using either of the two local buses, personal car, or by taxi[106]. A light rail link (Tvärbanan) will be commissioned in 2013 and will operate near the airport providing additional options to passengers[107].

[106] Bromma Stockholm website – Parking & transport http://www.swedavia.com/bromma/to-and-from/finding-the-airport/

[107] Swedavia website – Facts about Stockholm Bromma Airport http://www.swedavia.com/bromma/about-bromma-stockholm-airport-/about-the-airport/facts-about-the-airport/

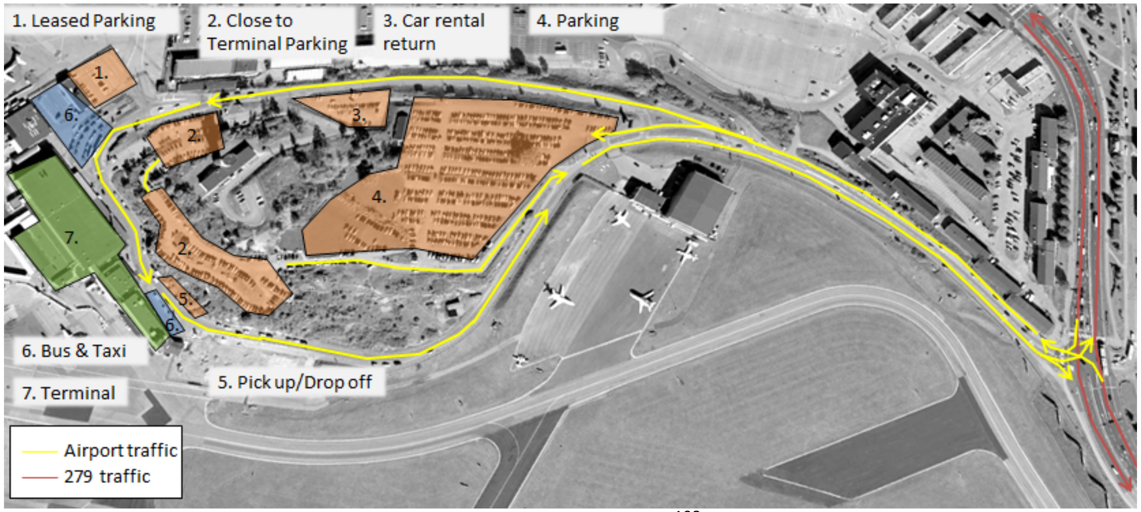


Fig 9.6 Groundside network – Bromma-Stockholm Airport[108]

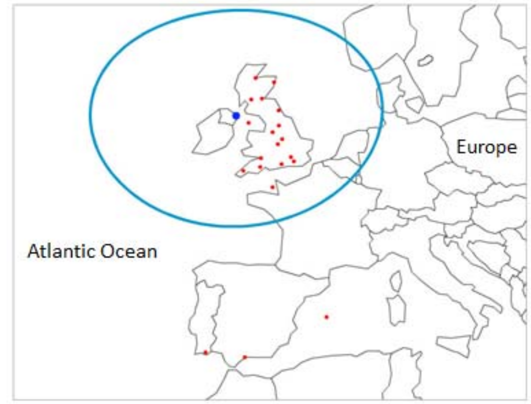
The following table describes high level benefits and drawbacks associated with the operation of the Bromma-Stockholm Airport from the point of view of the operator.

Benefits	Drawbacks
• Proximity to downtown • Simple noise cap in place based on average EPNDB level • Reliever Airport to Arlanda-Stockholm (same operator)	• Curfew starts at 9pm. • No on-airport light rail link

Table 9.7 Benefits and Drawbacks of Bromma-Stockholm Airport

[108] Bromma Stockholm Airport website http://www.swedavia.com/PageFiles/3522/BMA_P_eng.pdf

GEORGE BEST BELFAST CITY AIRPORT, NORTHERN IRELAND



Belfast Harbour Airport was opened in 1938 and was mainly used as a RAF Base during World War II. In 1952 the runway was extended to 6,000ft. Scheduled passenger flights were recommenced in 1983[109].

A Planning Agreement was signed between Belfast City Airport Limited Short Brothers PLC and The Department of the Environment for Northern Ireland in 1997. This set out the movement cap of 45,000 per 12 months, the seat sale limit of 1.5 million per 12 months (which has since been increased to 2 million) and the operational hours of 06:30-21:30[110]. Furthermore, the majority of the flights must take off and land over Belfast Lough (Bay) when the wind permits.

In 2008 the airport applied for planning permission to extend the runway by 590m at the north east end. The extension involved lengthening the runway itself by 350m, a 240 m area comprising a starter strip and a turning loop. This extension also proposes a retraction of the south west end of the runway by 120m[111]. The airport comments that the current runway length limits the amount of fuel in aircraft and a longer runway would enable planes to travel further into mainland Europe[112]. These plans have not been approved and in 2010 Ryanair pulled out of the airport after a public inquiry into the proposed runway extension suffered further delays[113].

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[109] George Best Belfast City Airport – Website -
[110] Planning NI – Northern Ireland Planning Portal - Website
[111] Civil Aviation Authority Report – Noise Aspects of Planning Application for Runway Extension
[112] George Best Belfast City Airport – website – The Runway Extension The Facts
[113] Belfast Telegraph – Article on 27th Jan 2012

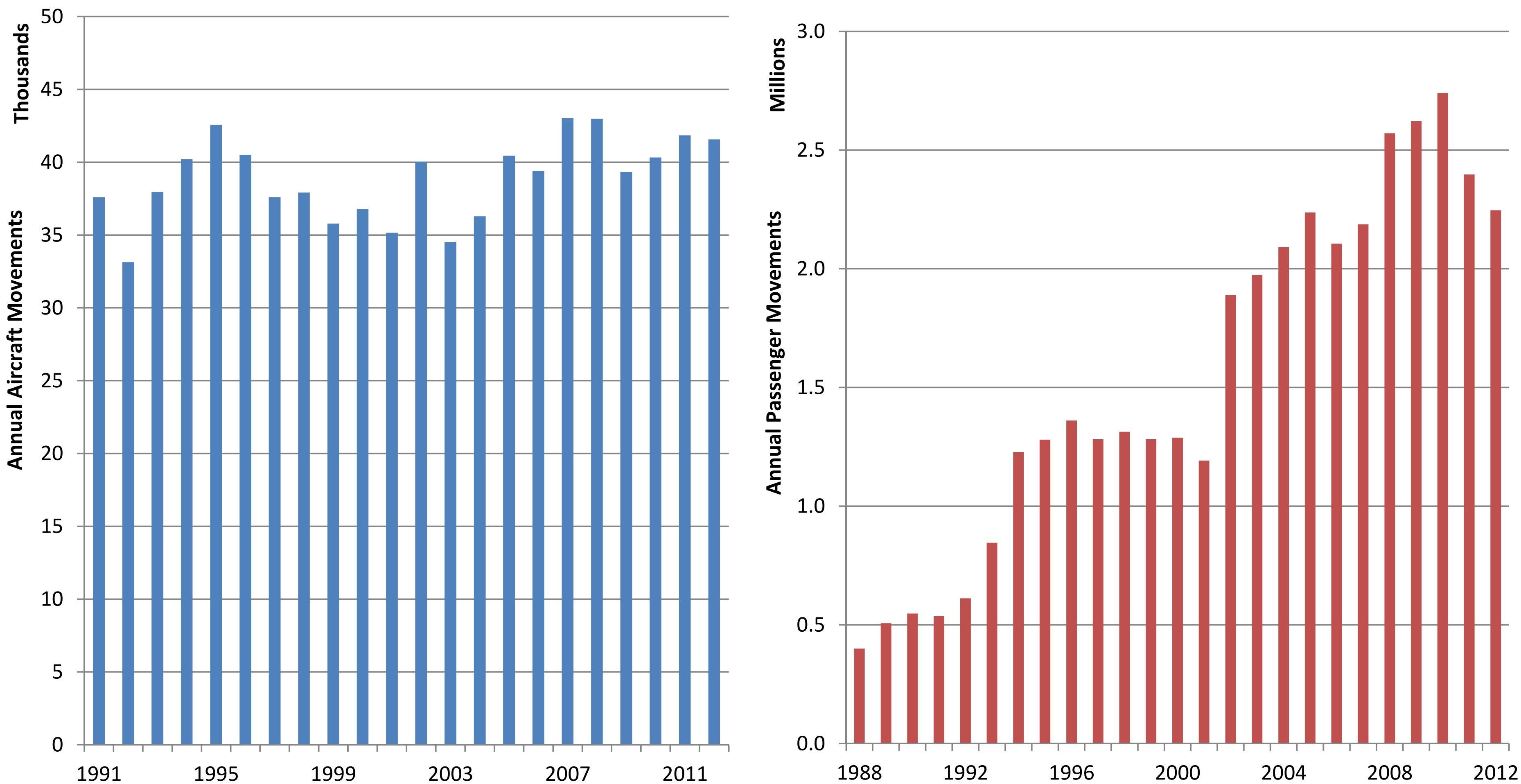

Fig 9.7 **George Best Belfast City Airport (BHD) Airport Annual Aircraft and Passenger Movements** [114]

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[114] Annual Movements taken from Civil Aviation Authority (caa.co.uk)

Fig 9.8 Belfast City Airport (BHD) Airport Overlay

In 2012 Belfast City Airport requested that the Seats for Sale restriction be removed from the agreement and replaced with a noise contour control cap and other noise control measures. This request has been considered and is subject to the outcome of a public consultation process and an independent public examination[115].

The following table presents a week of operations based on 20-26 May 2013 at the George Best Belfast City Airport.

Aircraft	Engine	MTOW (tonnes)	Movements
Airbus A320	Jet	74	46
Airbus A319	Jet	64	150
Embraer ERJ-195	Jet	52	166
Embraer ERJ-175	Jet	40	28
Dash8-Q400	Turboprop	29	352
Let 410 Turbolet	Turboprop	6	40
TOTAL			**782**
AVG DAILY			**112**

Table 9.8 George Best Belfast City Airport - Weekly Commercial Movements – 20 May 2013 Schedule

There are currently 4 airlines operating from Belfast City Airport. The dominant airline is Flybe with 63% of the weekly seats[116]. Flybe's fleet consists of 57 Dash 8-Q400 aircraft, 14 Embraer E-195 aircraft and 9 Embraer E-175[117].

The majority of the flights leaving Belfast City Airport are to UK destinations within a 500nm range. The 3 European destinations shown; Malaga, Faro and Palma, are new destinations for Aer Lingus started this year (2013). Additional European flybe destinations not present in the schedule include Paris, along with winter charter destinations Memmingen and Salzburg[118]. There are a number of constraints existing at George Best Belfast City Airport which are summarised in the Key Operational Specifications table below.

[115] Planning NI – Northern Ireland Planning Portal - Website
[116] SABRE (20-26 May 2013 schedules)
[117] Flybe website – About our fleet
[118] George Best Belfast City Airport – Website – Available Routes

Specifications	Value
Number of Runways / Length	1 (1,829m / 6,000 ft)
Glide Slope	3°
Distance from Downtown	5 km
Annual Aircraft/Passenger Movements	41,500 / 2.2 million
Hours of Operations	06:30 to 21:30
Movement Cap	48,000 movements per year (exclude training/military) 4 million seats for sale per year
Noise Cap	n/a

Table 9.9 Key Operational Specifications – Belfast City Airport

When commuting between the airport and the city, passengers have the option of; a shuttle bus between the airport and the adjacent rail halt in Sydenham, 3 local bus services, personal car or by taxis[119]. However, the annual passengers for Belfast City Airport for 2012 consisted of 2,232,913 scheduled passengers and 13,289 charter passengers[120].

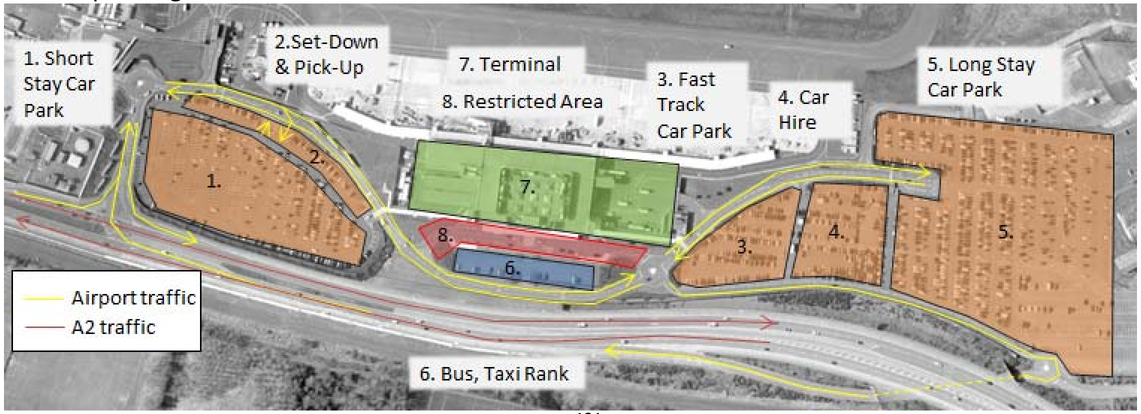


Fig 9.9 Groundside network – Belfast City Airport[121]

The following table describes high level benefits and drawbacks associated with the operation of the George Best Belfast City Airport from the point of view of the operator.

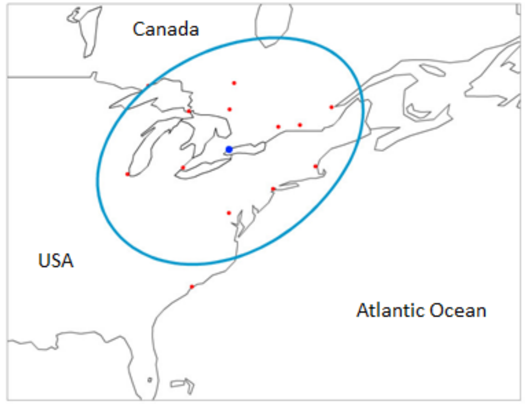
Benefits	Drawbacks
• Proximity to downtown • Longer Runway compared to other urban airports • Nearby train station	• Residential dwellings within noise contours • Operations end at 21:30pm • Restrictions on seats for sale • Low public transport usage

Table 9.10 Benefits and Drawbacks of Belfast City Airport

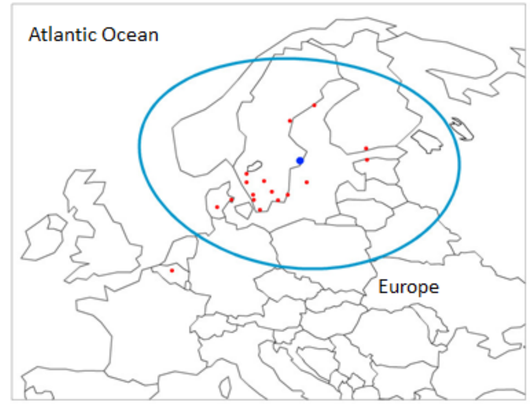
[119] Belfast City Airport website – To and from the Airport
http://www.belfastcityairport.com/To-and-from-the-airport.aspx
[120] CAA
[121] George Best Belfast City Airport website
http://www.belfastcityairport.com/Airport-Information/Airport-layout/Terminal.aspx
http://www.belfastcityairport.com/About-Us/Airport-Development-and-Planning/Airport-Reconfiguration.aspx

SUMMARY

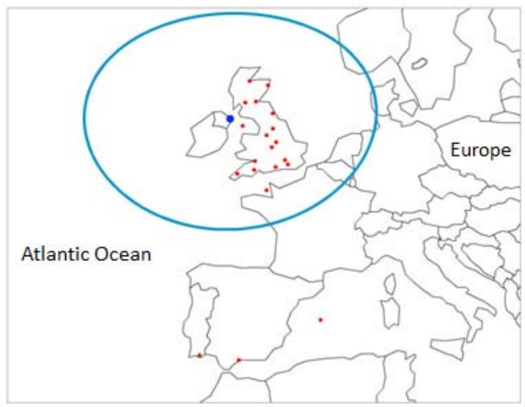
This section has presented several airports in an urban and/or waterfront setting with a development scale similar to BBTCA in size and passenger movements.



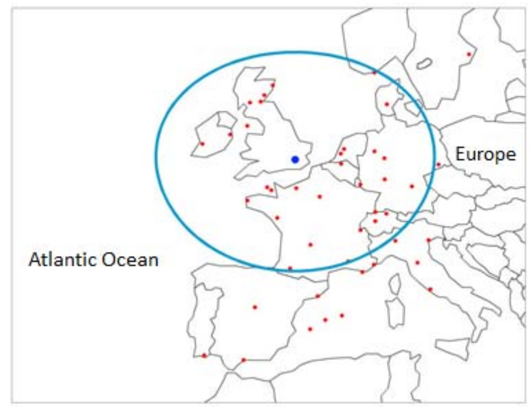
Billy Bishop Toronto City Airport



Bromma-Stockholm Airport



Belfast City Airport



London City Airport

Fig 9.10 Case Study Airports and YTZ Route Network with 500nm Range Circle[122]

[122] Based on SABRE (20-26 May 2013 schedules) destinations

This summary table highlights the operations at urban airports similar to BBTCA. It shows that these comparable airports are all operating within a cap system, but all allow jet aircraft operations.

	Billy Bishop Toronto City Airport	London City Airport	Bromma-Stockholm Airport	George Best Belfast City Airport
IATA Code	YTZ	LCY	BMA	BHD
Country	Canada	United Kingdom	Sweden	United Kingdom
Major Airport	Toronto-Pearson	London Heathrow	Arlanda-Stockholm	Belfast Airport
Distance from City	-	11km	8km	5km
Passengers (2012)	2.3 million	3.0 million	2.2 million	2.3 million
Aircraft (2012)	111,000 (2011)	71,000	47,000	42,000
Jets Allowed	No	Yes	Yes	Yes
Hours of Operation (Weekdays)	6:45-23:00	6:30-22:30	6:00-21:00	6:30-21:30
Approach Slope	3.9°-4.8°	5.5°	3.5°	3.0°
Movement Cap	Noise-Based Quotas Currently 202 daily commercial slots	120,000 annual movements and daily restrictions. Noise-based quotas Partial weekend curfew	80,000 Annual (including 20,000 aircraft with more than 60 seats and EPNdB 86-89)	48,000 annual movements 4 million seats for sale per year
Rail Link	Off-Airport Light Rail	On-Airport Rail Station	Off-Airport Light Rail	Off-Airport Rail Station

Table 9.11 Case Study Airports Summary

10. COSTS ESTIMATE AND FINANCIAL FEASIBILITY

As part of this review, order of magnitude costs were developed for the proposed runway extension. The information provided is not sufficiently detailed to allow the project to proceed for a fixed-price tender call; as such the estimate should not be considered as the final estimated cost of the proposed development.

The cost estimate relates solely to the proposed Runway 08-26 extension at both ends for the 168m option (Proposal #1) and for the 200m option (Proposal #2). Total order of magnitude costs estimates were assessed at $80 million (Proposal #1) and $92 million (Proposal #2). Further work on the conditions of existing infrastructure may lead to additional costs that could significantly affect this preliminary estimate.

Potential impacts have been identified throughout this review that may result in additional costs associated with the upgrade of existing facilities such as:

- Runways;
- Taxiways;
- Apron;
- passenger terminal building; and
- aviation support facilities.

The cost of additional land reclamation and construction cost for the provision of a parallel runway at both runway ends was not reviewed. Financial feasibility of this proposed expansion has yet to be addressed as additional costs that may be indirectly associated to the runway extension have not been fully identified.

11. AIRSPACE CONSIDERATIONS

This section is aimed at reviewing airspace considerations associated with the Porter Airlines runway extension proposals. It includes a description of the existing and projected considerations under each extension proposal. It also includes a discussion on steep approach landings as well as a peer review of a TP308 Impact Study on the instrument approach and departure procedures at the BBTCA.

EXISTING RUNWAY 08-26 LAYOUT

The existing Runway 08-26 layout consists of a 1,216m long runway used over its full length for both take-off and landing operations. A 90m pre-threshold area located at both runway ends cannot be used for aircraft operations and is not considered as a Runway-End Safety Area (RESA) as defined in Transport Canada's TP312 standards and recommended practices.
The following image highlights schematically how operations occur on Runway 08-26. Note that all dimensions are not to scale and are meant to enable a comparison with the two proposals presented in subsequent sections.

CURRENT

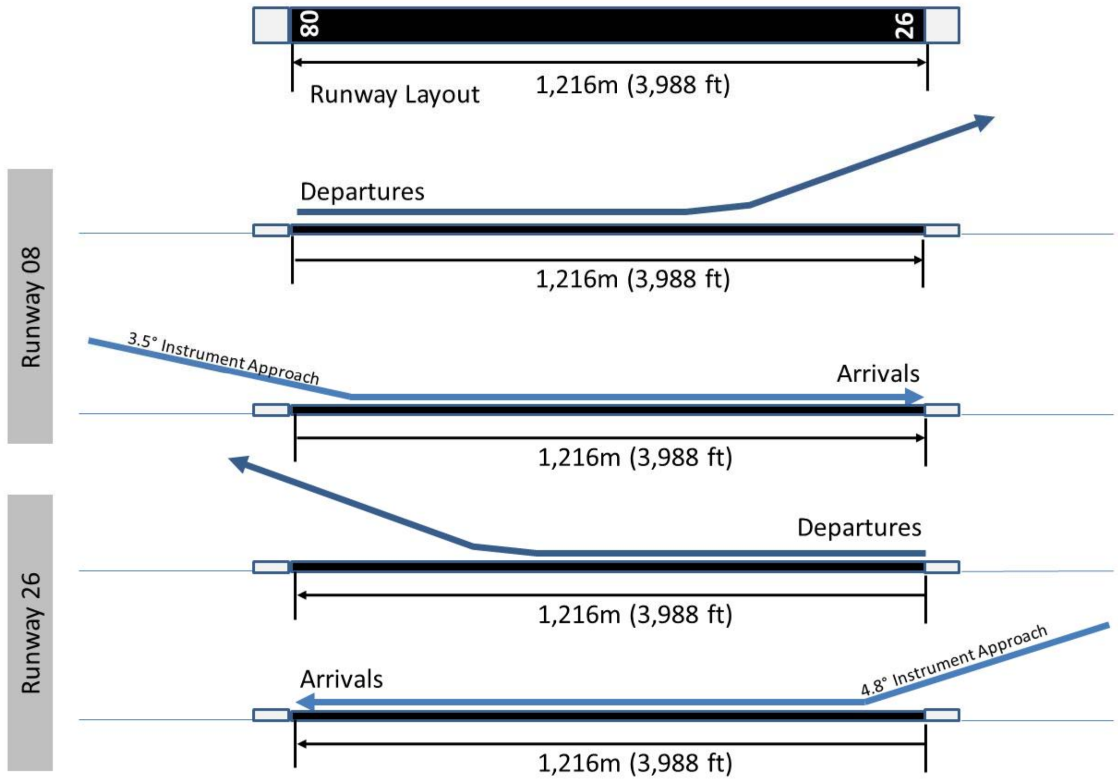


Fig 11.1 Current Runway Layout and Operations (Not to scale)

PROPOSAL #1: 168M EXTENSION INTO WATER

This Runway 08-26 concept (Proposal #1) was the baseline concept initially provided by Porter Airlines. It is characterized by the following specifications.

Key Specifications	
Take-Off Run Available (TORA)	1,569 m (5,148 ft)
Landing Distance Available (LDA)	1,399 m (4,590 ft)
Approach/Take-Off Surfaces	Unchanged
Runway thresholds	Shifted 60m to match Approach/Take-off Inner Edge

Table 11.1 Proposal #1 – Key Specifications

It is understood that this proposal was not submitted to Transport Canada.

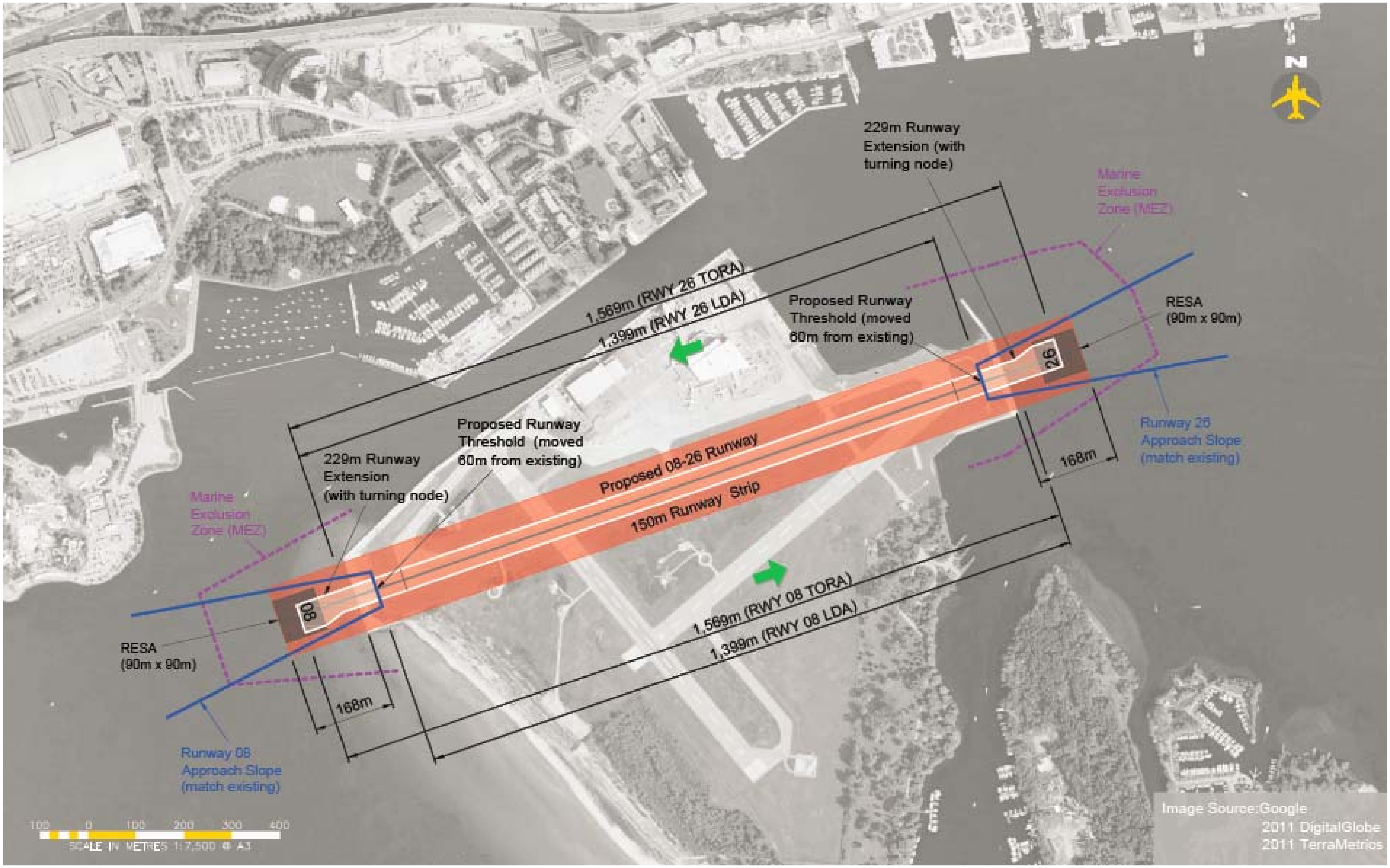
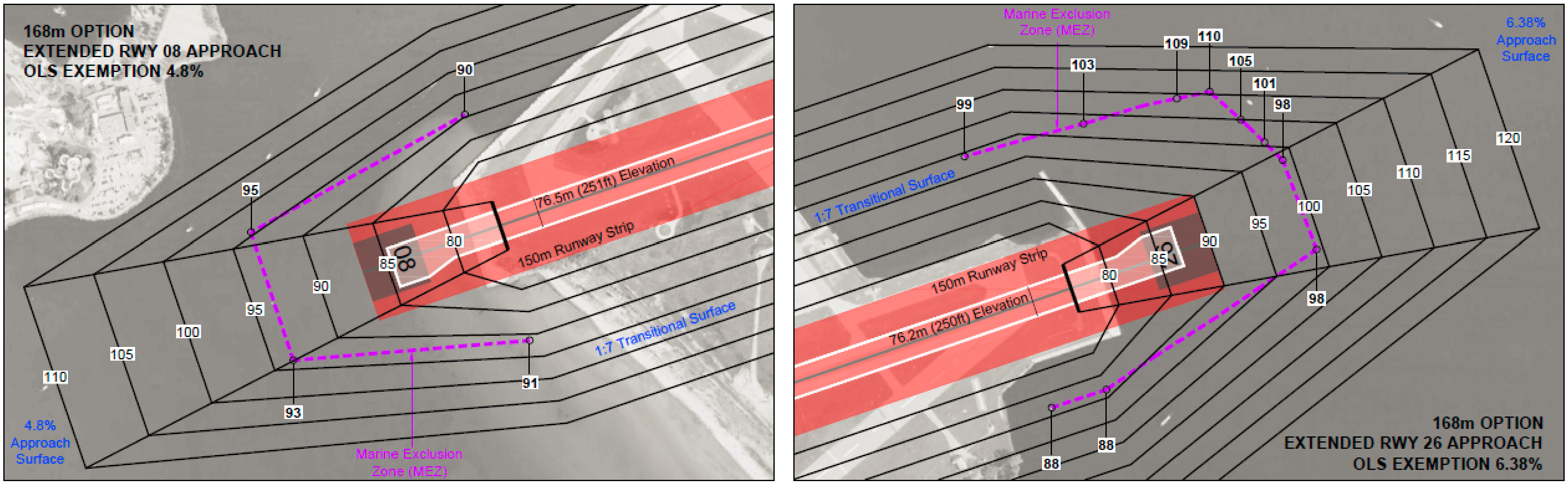


Fig 11.2 Proposal #1 – 168m extension into water at each runway end

Proposal #1 is aimed at achieving a targeted take-off distance while maximizing the landing distance available by displacing the landing threshold by 60m without impacting the location of the approach splays. However, the widening of the runway strip due to the Code 3 classification of the runway leads to a lateral displacement of some of the existing buoys.

The following images illustrate these obstacle limitation surfaces at both runway ends based on existing exemptions. A key element highlighted is the fact that although the runway is lengthened, the location of the approach surface for this option remains unchanged hence protecting the extent of the existing Marine Exclusion Zone.



Note:1. OLS is based on Nav Canada Published Runway End Elevations (in metres)
2. MEZ locations are indicative only

DRAFT

Fig 11.3 **Proposal #1 – Indicative Obstacle Limitation Surfaces**

The following image highlights schematically how the runway extension would impact landing and take-off operations on Runway 08-26. Note that all dimensions are not to scale.

This proposal shows that the runway lengthening would increase the take-off run available by making use of a portion of the Runway-End Safety Area. For landings, the approach slope is marginally displaced (by 60 metres) without impacting existing obstacle limitation surfaces. This explains why the landing length available is shorter than the length available for take-off.

PROPOSAL #1

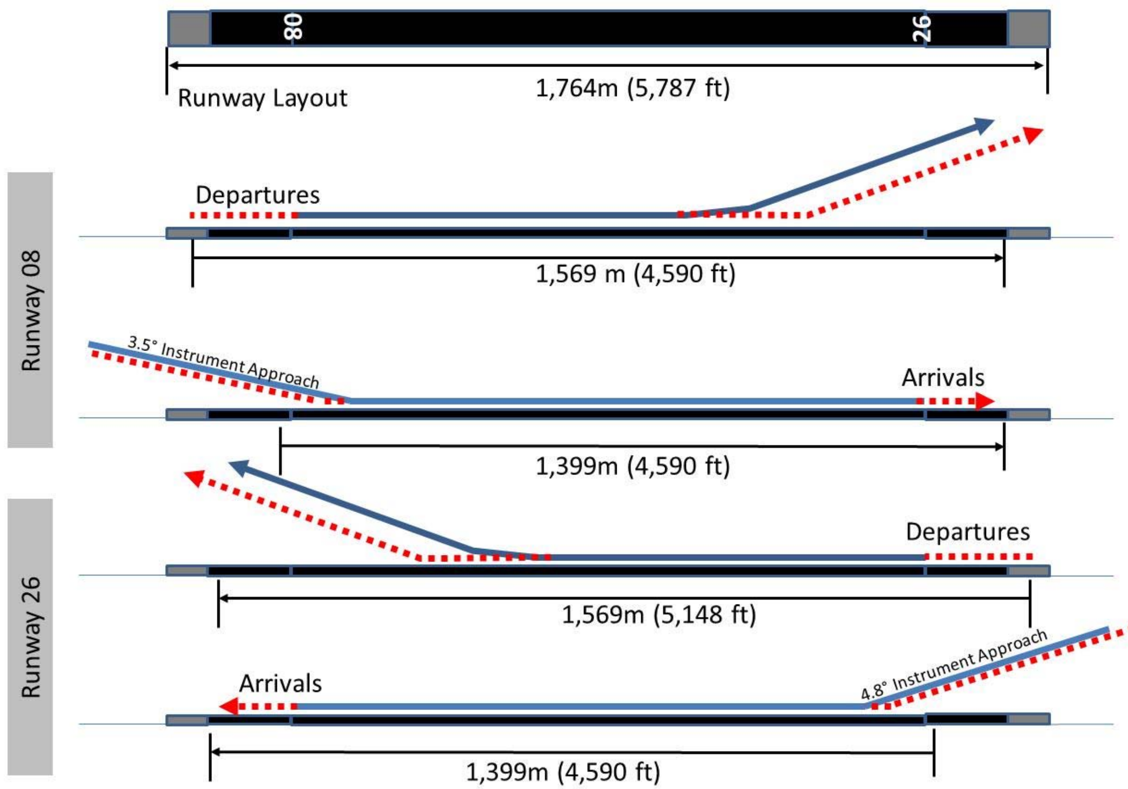


Fig 11.4 Proposal #1 - Runway Layout and Operations (Not to scale)

PROPOSAL #2: 200M EXTENSION INTO WATER

This concept (Proposal #2) was submitted on 3 September 2013 by Porter Airlines as an alternate solution for consideration. Porter Airlines has submitted this proposal to be considered in conjunction with Proposal #1. Porter Airlines have not expressed a preference for either proposal at this stage. It is characterized by the following specifications.

Key Specifications	
Take-Off Run Available	1,632 m (5,354 ft)
Landing Distance Available	1,371 m (4,498 ft)
Approach/Take-Off Surfaces	Displaced inwards by 60m at both runway ends.
Runway Thresholds	Unchanged

Table 11.2 Proposal #2 – Key Specifications

It is understood that this proposal was submitted to Transport Canada and subsequently updated in a revision to the original proposal. The key change involves an increase in the Take-Off Runway Available to 1,656m (5,433 ft) that otherwise does not impact other specifications of the original proposal.

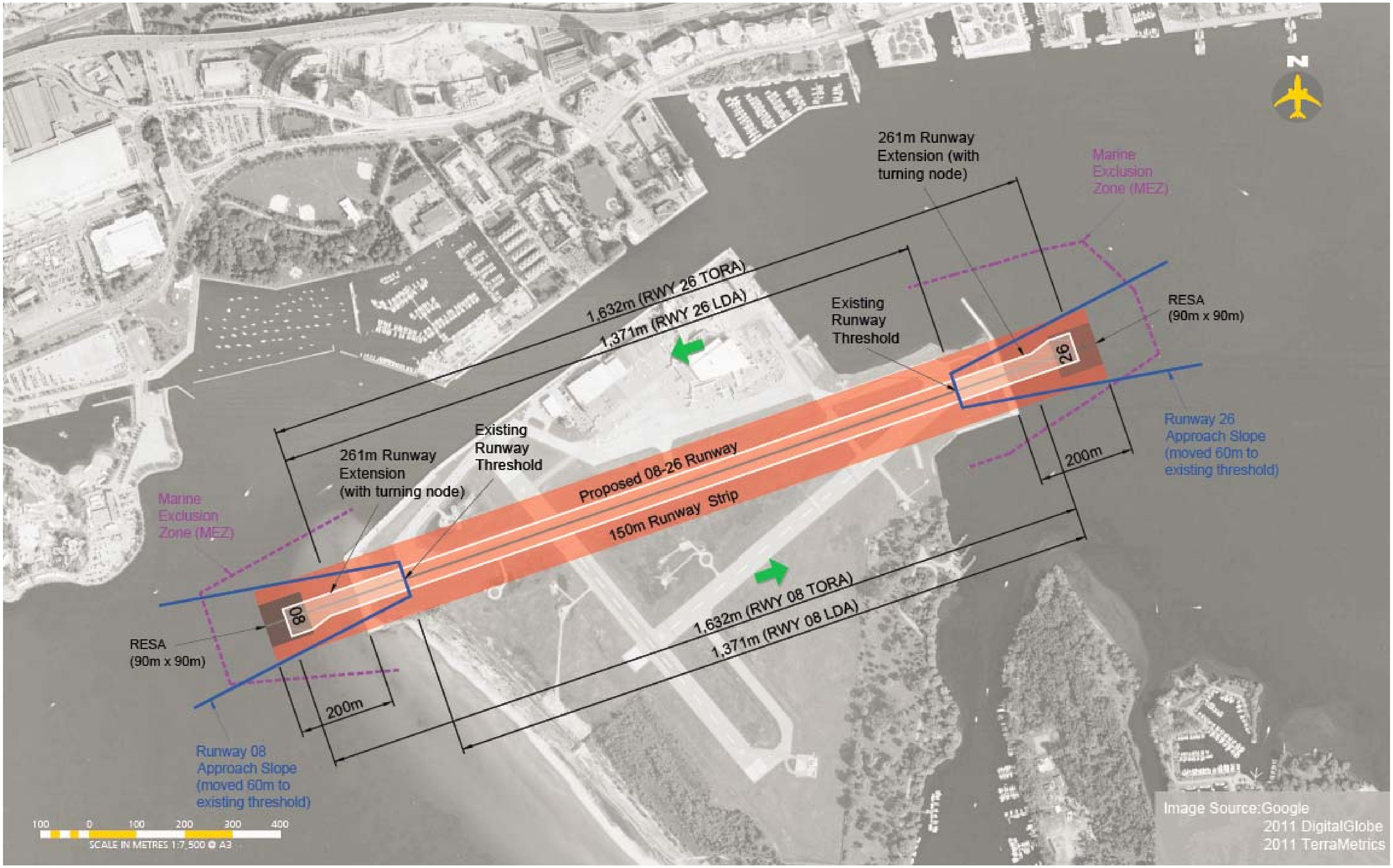
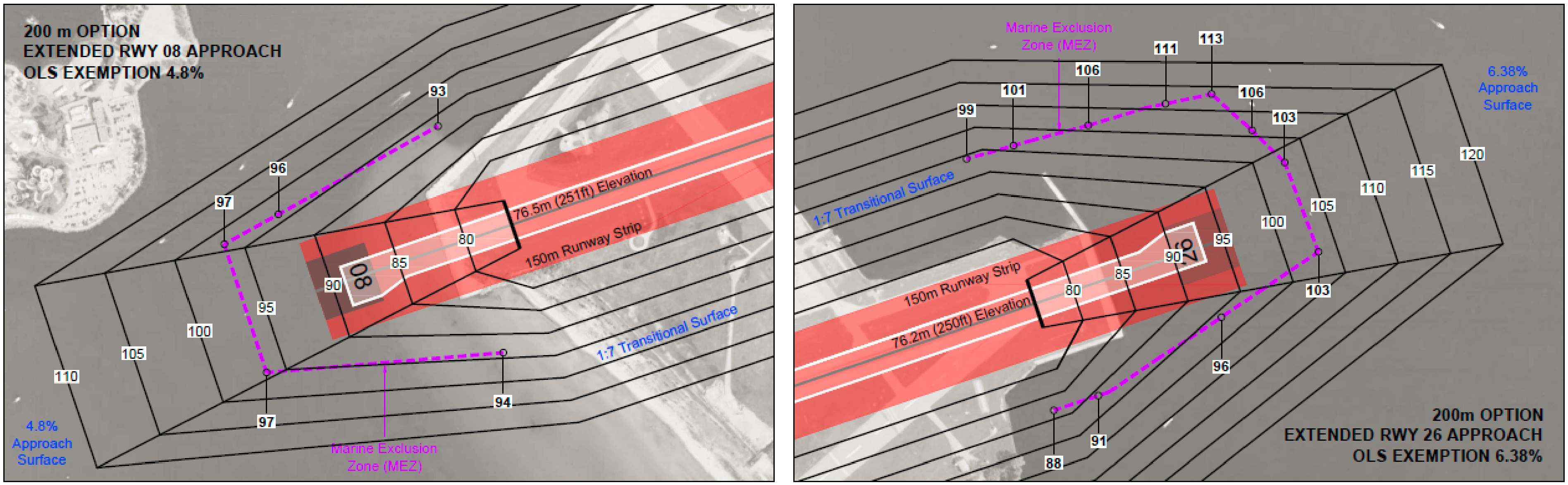


Fig 11.5 **Proposal 2: 200m extension into the water at each runway end**

The main feature of Proposal #2 is the landing threshold remaining at its existing location to minimize the lateral displacements of some of the existing Marine Exclusion Zones (MEZ) buoys. By doing so, the take-off run available would be increased by 64m. However, the landing length available would be reduced by 28m.

The following images illustrate these obstacle limitation surfaces at both runway ends based on existing exemptions. A key element highlighted is the fact that although the runway is lengthened, the location of the approach surface for this option is moved inwards by 60 metres hence preserving the extent of the existing Marine Exclusion Zone.



Note:1. OLS is based on Nav Canada Published Runway End Elevations (in metres)
2. MEZ locations are indicative only

DRAFT

Fig 11.6 **Proposal #2 – Indicative Obstacle Limitation Surfaces**

The following image highlights schematically how the runway extension proposed in Proposal #2 option would impact landing and take-off operations on Runway 08-26. Note that dimensions are not to scale. This proposal shows that the runway lengthening would increase the take-off run available by making use of a portion of the Runway-End Safety Area at the runway.

For landings, the approach slope remains identical. This explains why the landing length available is shorter than the length available for take-off.

Any noise mitigation benefits are difficult to quantify. Although some benefits may occur on take-off due to a scaled-back thrust level, this could be offset by an increased need for reverse thrust on landing due to the shorter runway length or by the ability of heavier aircraft to take-off on this longer runway.

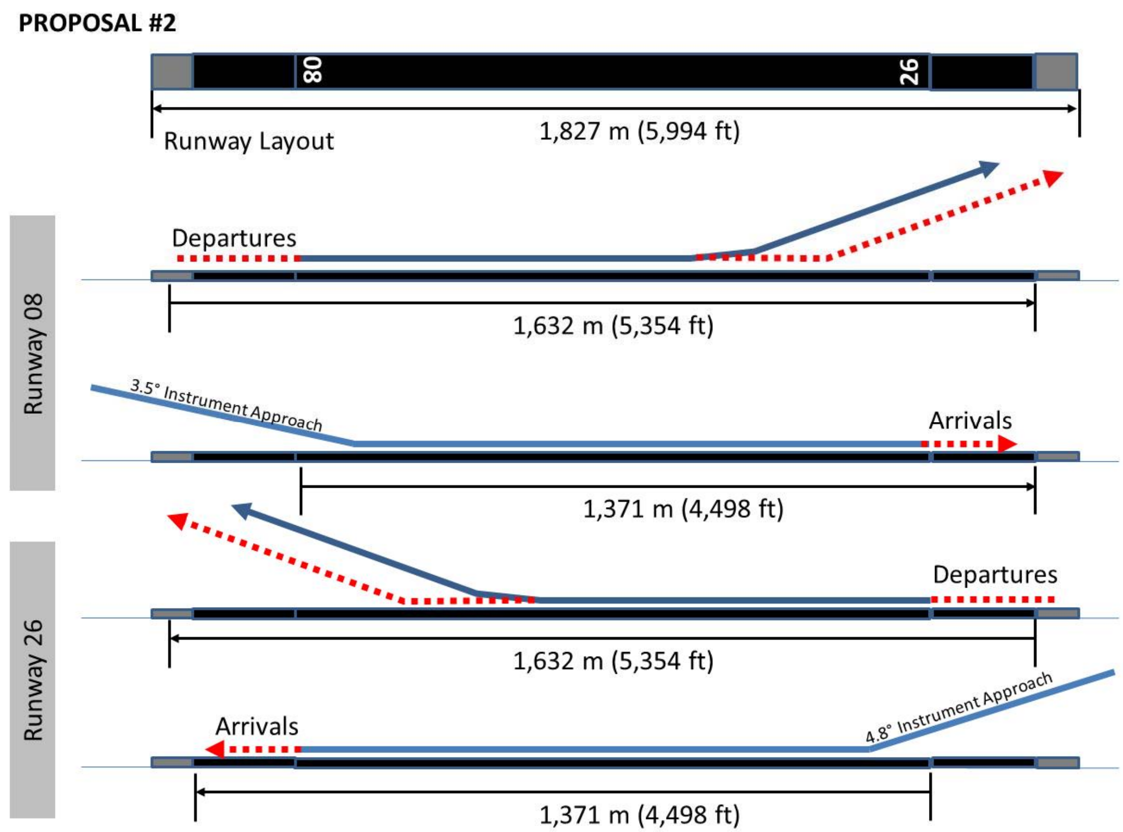


Fig 11.7 Proposal #2 - Runway Layout and Operations (Not to scale)

TP 308 IMPACT STUDY PEER REVIEW

This review of airspace considerations is intended to provide a cursory review of the supplied study information only (Proposal #1). A complete technical analysis for TP308 criteria compliance was not within the scope of this study, therefore any conclusions, conditions, and actual suitability of any instrument flight procedure as proposed is the responsibility of the original design organization.

Porter Airlines is proposing new operations to Billy Bishop Toronto City Airport (CYTZ) using CS100 jet aircraft. A lengthening of the main runway would be required to support this operation. As part of the City of Toronto's assessment of the Porter Airlines proposal, Direct Approach Consulting has been requested to review Porter Airlines' instrument approach consultant's conclusions based on the first proposal (168m extension).

FINDINGS

The CS100 aircraft proposed by Porter Airlines is an approach category "C" aircraft. These categories are based upon the normal approach speed of the aircraft. Category "C" is based on approach speeds ranging from 121 to 140 knots while Category "B" is based on approach speeds ranging between 91 and 120 knots.

The document that describes the instrument approach and departure design requirements is "TP308 - Criteria for the Development of Instrument Procedures".

Category C aircraft Glidepath angles (GPAs) for either Instrument Landing System (ILS) or Global Navigation System (GNSS) vertical guidance approaches are limited to a normal maximum angle of 3.6°.

An exemption is currently granted on the ILS/DME RWY 26 permitting a Glidepath angle (GPA) of 4.8°. This approach is currently in the Restricted Canada Air Pilot (R-CAP) and authorized for approach Category A and B aircraft only. In order for Porter Airlines' aircraft to use a 4.8° GPA approach the exemption must be extended to include Category C aircraft.

The glidepath for the ILS/DME RWY 08 approach is proposed to increase from 3.5° to 3.9°. A new TP308 exemption would be required to authorize this steeper GPA. The resulting approach if approved would need to be moved from the Canada Air Pilot (CAP) and published instead in the R-CAP. This would mean that private IFR aircraft, or aircraft without the required OPS SPEC, would not be authorized to fly this approach leaving the BBTCA without a publicly available ILS as a result. It is understood that for Proposal #2, the glidepath would remain unchanged at 3.5°.

Applications for approval of non-standard instrument approach procedures (IAPs) must be submitted to Chief Air Navigation Services (ANS) Operations Oversight at Transport, Ottawa. Transport Canada is normally quite hesitant to grant exemptions to the design criteria without significant supporting justification as to why such an exemption is “in the public interest” and how an “equivalent level of safety”[123] can be maintained despite the deviation from criteria. Transport Canada’s willingness to consider these specific approach parameters should be ascertained before committing significant resources.

There were no speed restrictions on any of the airport’s Standard Instrument Departures (SIDs), Standard Terminal Arrival Routes (STARS), approaches, or departures other than the ‘C’ Category approach issues already discussed. Therefore except for possible increases in wake turbulence separation, no significant adverse airspace or ATC issues are considered likely to occur.

The Toronto-Pearson International Airport and BBTCA are co-dependent with regard to the ability to operate aircraft in the general Toronto Terminal Airspace. However, that is not affected by the proposed lengthening of the runways.

Since the Runway 08/26 capacity is not increased by the lengthening, this proposal will not increase the demand on the Toronto Terminal Airspace. Further study should be undertaken with NAV Canada to confirm these interim findings.

STEEP APPROACH LANDINGS

Steep approach landings are used at a range of airports worldwide, though more often in urban settings, as a means to clear man-made or natural obstacles as well as to reduce noise impacts in the vicinity of the airport by allowing aircraft to maintain a higher altitude during the approach phase of the flight. Operations by commercial aircraft of these steeper approach paths must be approved by the regulator. In Canada, these guidelines are set in Advisory Circular 525-011[124]. This document provides information on the requirements for the approval of steep approach landing capability of Transport Category aircraft using an approach path angle greater than or equal to 4.5 degrees (7.9 %). Currently, Runway 08 ILS approaches are performed at 3.5 degrees while Runway 28 ILS approaches are performed at 4.8 degrees which is considered steep.

Modelling of the noise impact of steeper approaches was undertaken generically using the Integrated Noise Model (INM), a U.S. Federal Aviation Administration software, used broadly around the world to

[123] Advisory Circular (AC) No. 803-004, Restricted Instrument Procedures, Transport Canada

[124] Approval of Steep Approach Landing Capability of Transport Category Aeroplanes, AC 525-011, Transport Canada, 2004

assess the impacts of aircraft noise using a range of metrics. The following figures illustrate the sound exposure level (SEL) of a Dash8-Q400 landing on Runway 08 at a 3 degree slope compared with a landing at a 3.5 degree slope as well as a landing on Runway 26 at a 3 degree slope compared with a landing at a 4.8 degree slope. Results assume a straight approach and comparable aircraft performance specifications for both slopes. It highlights the sizeable reduction in noise contours along the flight path of the aircraft although the model only highlights comparable impacts at ground or water level.

Fig 11.8 **Noise Modelling – Steep Approach Impacts – Runway 08**

Fig 11.9 **Noise Modelling – Steep Approach Impacts – Runway 26**

12. SUMMARY OF KEY FINDINGS

The key findings are listed in the table below and are provided as a reference to where the primary points of concern are at this stage of the study:

Chapter	Topic	Key Findings
04 Design Aircraft		
	General Aviation Jet Aircraft	Current smaller General Aviation jet aircraft will meet the noise requirements within the Tripartite Agreement.
	Commercial Jet Aircraft	Current narrowbody jet aircraft will not meet the noise requirements within the Tripartite Agreement .
		Some current regional jet aircraft meet the noise requirements within the Tripartite Agreement.
		Future commercial aircraft comparable to the CS100 are expected to be able to meet the noise requirements within the Tripartite Agreement.
	Bombardier CS100	CS100 performance standards are predicated on information from Bombardier.
		Static engine test results and preliminary flight test results were disclosed and found to be in compliance with the limits set in Tripartite Agreement.
		The CS100 will not be certified by Transport Canada until May 2014 (based on current information).
05 Capacity Assessment		
	Slot Cap	Is assumed to remain at 202 movements for the purpose of this study but could change over time based on changing operational conditions, fleet mix and noise modelling methodology.
	Runway	The proposed runway extension does not increase runway capacity.
	Taxiway	Backtracking on runway by aircraft due to restrictions on Taxiway D would restrict runway capacity during busy hours unless a compliant parallel taxiway is provided as part of the extension.
	Annual Capacity	Annual passenger processing capacity is projected to increase from 3.8 million to 4.3 million passengers if commercial jet aircraft are allowed at BBTCA and the slot cap remains unchanged.
	Busy Hour Capacity	During busy hours, one-way passenger movement capacity could increase from 870 to 1,240 passengers (including transferring passengers) if operations are unrestricted by scheduling caps.
	Terminal	Terminal facilities would require upgrades to passenger processing facilities if CS100 operates during busy periods.
	Apron	The current 10 apron stands are not proposed to be added to within this proposal.

Chapter	Topic	Key Findings
	Groundside	Pedestrian tunnel busy hour capacity exceeds the ferry service capacity and therefore contributes to an overall increase in the airport system busy hour capacity.
06 Infrastructure Requirements		
	Runway Code	Runway 08-26 is expected to be revised from a Code 2 runway to a Code 3 runway under both proposals.
	Runway Usability	Based on a 20 knot crosswind tolerance, CS100 and Dash8-Q400 can operate on Runway 08-26 99.77% of the time, well in excess of international standards (95%).
	Obstacle Limitation Surfaces	Existing OLS exemptions require confirmation from Transport Canada that they can apply for a Code 3 runway.
	Airport Zoning Regulations	Impacts of both proposals on existing Runway 08-26 Airport Zoning Regulations must be confirmed with Transport Canada.
	Proposed Runway Extension	Preliminary information confirms the ability of the CS100 to operate within the parameters of both proposed runway extension proposals.
	Runway End Safety Areas	These are likely to become a requirement at Canadian airports in the near future. It has therefore not been confirmed whether RESAs will be required under the status quo (Runway remains Code 2) but any runway extension project would need to plan accordingly for RESAs.
	Taxiways	Taxiway D is restricted due to the proposed changes which will likely reduce the overall runway utilization at busy hours unless a new taxiway is associated with the runway extension proposals.
	Apron	The apron will require alteration to accommodate the operation of up to 4 CS100 aircraft gates at the West and East apron areas.
	Jet Blast Considerations	CS100 has smaller jet blast impacts compared to current generation aircraft due to the increased engine air bypass ratio of the geared Turbofan. Associated jet velocities may still impact harbour navigation and should be reviewed for the CS100 and other jet aircraft likely to operate at the BBTCA.
	Pavement Strength	The CS100 has an aircraft classification number (ACN) in excess of the pavement rating at the BBTCA. More detailed study on required pavement upgrades should be undertaken.
	Terminal	The terminal will require expansion in a number of areas to accommodate increases in passenger processing capacity.
	Groundside	The commissioning of the pedestrian tunnel will increase groundside capacity and will enhance the passenger flows in and out of the passenger terminal building.

Chapter	Topic	Key Findings
07 Noise Considerations		
	Noise Disclosure	Attempting to correlate noise metrics with impacts on the community is complex as aircraft noise as experienced by an individual is highly subjective.
		Refraction of sound over water and refraction of sound off buildings and water contribute to the complexity of noise propagation in the vicinity of the airport.
	Aircraft Noise	The CS100 is expected to operate at or below the requirements within the Tripartite Agreement.
		It is not possible to reliably assess the impact of the CS100 aircraft on compliance to the NEF contours in the Tripartite Agreement.
		Compliance of CS100 certification noise levels to the Tripartite Agreement noise limits can only be confirmed upon completion of test flights and formal noise certification by Transport Canada.
		Future jet aircraft, comparable to the CS100, are expected to operate at or below the requirements set within the Tripartite Agreement.
		Current small general aviation and regional jet aircraft operate at or below the requirements within the Tripartite Agreement. Health Impact Assessment was conducted based on a Tripartite Agreement Compliant jet aircraft using the Boeing 737-700 as a proxy.
	Engine Run-Ups	60 maintenance engine run-ups were conducted at BBTCA between October 2012 and September. Tests occurred near Runway 33 threshold between 645am and 1100pm. Pratt&Whitney expect a significant reduction in maintenance engine run-ups for the CS100 compared to the Dash8-Q400.
08 General Aviation		
	GA Operations	GA operations are not expected to be physically negatively affected by the introduction of the CS100 although apron changes could impact GA aircraft parking.
		A runway extension not associated with a taxiway system may lead to a reduction in airfield capacity or lead to the use of intersection departures for smaller general aviation aircraft.
		Type of GA operations could change if jet ban is lifted and small jet aircraft start utilizing the airport
		The two cross runways remain available for GA activity to provide optimal crosswind coverage.
09 Case Studies		
	General Findings	Jets are allowed at the airports reviewed, but operating under strict operational constraints including hours of use and limits on aircraft movements. Initiatives aimed at integrating these airports with their respective urban public transit system were also identified.

Chapter	Topic	Key Findings
10 Cost Estimate and Financial Feasibility		
	Runway Extension	Estimated cost of $80M (Proposal #1, 168m extension) and of $92M (Proposal #2, 200m extension).
	Pavement Rating	CS100 appears to exceed the pavement rating on existing runway, taxiways and aprons. Additional pavement engineering study may be required to confirm extent of upgrade works.
	Terminal Expansion and apron parking	Requirement, scope and costs were not addressed in this study.
	Financial Feasibility	Several considerations were identified beyond the scope of a runway lengthening into the water at each end which will impact the financial feasibility of this proposal (eg: pavement upgrade, new taxiways, apron upgrades).
11 Airspace Considerations		
	CS100 Airspace Considerations	Category 'C' approach designation based on normal approach speed of the aircraft.
		Normal maximum instrument approach angle is 3.6° for Category C aircraft.
		In order to use a 4.8° GPA approach the exemption must be extended to include Category C aircraft.
		Proposal #1 was the only option peer reviewed and would involve a new TP308 exemption from Transport Canada.
	Toronto Pearson Considerations	Toronto-Pearson and Billy Bishop Airports are co-dependent with regards to the ability to operate aircraft in the general Toronto Terminal Airspace. However that is not affected by the proposed lengthening of the runways. Approach's protected airspace would only be expended minimally on those missed approach sections already identified which would not have any effect on the total terminal's capacity.
	Proposal #1	Proposal #1 involves displacing the landing threshold by 60m without impacting the location of the approach splays. However, the widening of the runway strip due to the Runway Code 3 classification leads to a lateral displacement of some of the existing buoys.
	Proposal #2	Proposal #2 leaves the landing threshold at its existing location to minimize the lateral displacements of some of the existing Marine Exclusion Zones (MEZ) buoys. By doing so, the take-off run available is increased by 64m but the landing length available is reduced by 28m.
	Steep Approach	Steep approach procedures are used as a mean to clear man-made or natural obstacles and to reduce noise impacts in the vicinity of the airport. Approaches of 4.5% or more are deemed steep and require regulatory approval.

Table 12.1 Key Findings

13. GLOSSARY

ACI	Airport Council International
ANS	Air Navigation Services
A-PAPI	Asymmetric – Precision Approach Path Indicator
ASDA	Accelerate Stop Distance Available
BBTCA	Billy Bishop Toronto City Airport
CAEP	Committee on Aviation Environmental Protection
CAP	Canada Air Pilot
COPA	Canadian Owners and Pilots Association
DME	Distance-Measuring Equipment
E/D	Enplaned-Deplaned
EPNdB	Effective Perceived Noise in Decibels
FAA	Federal Aviation Administration
GNSS	Global Navigation Satelite Systems
GPA	Glide Path Antenna
IAP	Instrument Approach Procedures
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ILS	Instrument Landing System
LDA	Landing Distance Available
MTOW	Maximum Takeoff Weight
O/D	Origin/Destination
OPS SPEC	Operations Specifications
PAPI	Precision Approach Path Indicator
R-CAP	Restricted – Canada Air Pilot
RESA	Runway End Safety Area
RNAV	Area Navigation

SID	Standard Instrument Departures
STAR	Standard Terminal Arrival Route
TODA	Take-Off Distance Available
TORA	Take-Off Run Available
VLJ	Very Light Jet

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