5

Chapter

The Airside System

The Airside System

Chapter 5

5.1 INTRODUCTION

The airside and associated airspace system is of paramount importance in guiding the long-term development of Toronto Pearson International Airport. The ultimate capacity of the Airport will largely be defined by the capacity of the airside system that is already in a relatively advanced state of maturity. The development of the other major airport sub-systems including passenger terminals, cargo facilities, groundside access and various support functions will be undertaken in accordance with the airside infrastructure, to achieve a balanced system.

The airside system is instrumental in defining the overall capacity of the Airport for the following key reasons:

- Given the large land areas required for runways and their associated taxiways, operational areas and navigational aids, a finite number of runways can be accommodated within the Airport's physical boundary.
- As the regulator of aviation in Canada, Transport Canada sets the regulations and standards that must be complied with by the GTAA as the airport operator and by Nav Canada as the air navigation service provider in Canada. These regulations and standards are designed to ensure the safe operation of aircraft, but also place capacity limitations on an airport's airside infrastructure. In addition, the Airport Zoning Regulations associated with the airside infrastructure restrict the ability of the GTAA to develop certain lands as will be described in Chapter 14.
- The operation of aircraft produces a number of environmental impacts, including noise, air emissions and deicing/anti-icing fluid run-off. Efforts to mitigate these impacts have significantly influenced the design and operational use of the current airside system as well as future expansion plans. A consequence of environmental impact mitigation measures is often a reduction in the potential throughput capability of the airside system.

In the early 1990s, an environmental assessment was carried out by Transport Canada for the addition of three new runways at Toronto Pearson. Two of these runways have been constructed and commissioned. The third new runway that was approved as part of this process represents the final remaining element of the airside system at Toronto Pearson that will offer a significant increase in the overall airside capacity.

Significant expansion of the airside infrastructure beyond the plans discussed in this Master Plan, including the construction of any additional runways, is not presently deemed possible due to the lack of available land and environmental impact constraints.

5.2 EXISTING AIRSIDE SYSTEM

The primary components of the airside system are runways, navigational aids, taxiways, aprons, airside roads and deicing facilities. These elements are described in Sections 5.2.1 through 5.2.6 and are shown in Figure 5-1.

FIGURE 5-1 **EXISTING AIRSIDE SYSTEM**

	Airport Boundary		Aprons	GP	Glide Path
	Airside Roads		Central Deicing Facility Pads	LOC	Localizer
	Emergency Infield Access Road		Localizer	DVOR /DME	Doppler Very High Frequency Omni-Directional Range/ Distance Measuring Equipment
	Airside Tunnel		Glide Path		
	Runways		Other Navigational Aids	TSR	Terminal Surveillance Radar
	Taxiways			ASDE	Airport Surface Detection Equipment

TABLE 5-1 RUNWAY LENGTHS

Runway Orientation	Runway Name	Runway Length		Direction of Operation	Landing Distance Available	
		Metres	Feet		Metres	Feet
East/west	05-23	3,389	11,120	05	3,348	10,985
				23	3,242	10,635
	06L-24R	2,956	9,697	06L	2,956	9,697
				24R	2,896	9,500
	06R-24L	2,743	9,000	06R	2,743	9,000
				24L	2,743	9,000
North/south	15L-33R	3,368	11,050	15L	3,368	11,050
				33R	3,368	11,050
	15R-33L	2,770	9,088	15R	2,591	8,500
				33L	2,591	8,500

5.2.1 Runways

The present runway system at Toronto Pearson has five runways, oriented under two perpendicular alignments.

In an approximate east/west orientation, Runways 06L-24R and 06R-24L are closely spaced parallel runways located on the south side of the Airport. Consistent with international practice, the runways are named based on their magnetic bearings. For example, the 06-24 designation refers to magnetic bearings of approximately 60 degrees and 240 degrees at either end of these runways. When parallel runways exist, left and right designations are added to the runway names to distinguish between them. Parallel to these runways and located at the north end of the Airport is a third east/west runway, namely Runway 05-23. Although Runway 05-23 shares the same magnetic bearings as Runways 06L-24R and 06R-24L, the next closest designations of 05 and 23 are applied to provide a unique runway name.

In an approximate north/south orientation, there are two parallel runways. Runway 15L-33R is situated towards the easterly side of the Airport, while Runway 15R-33L is located on the west side of the airport site.

Table 5-1 provides the lengths of all five runways. While the full length of each runway is available for use by departing aircraft, some of the runways have displaced thresholds for landing aircraft. The resulting landing distance available in each direction of operation is also provided in Table 5-1. All runways at Toronto Pearson have a width of 60 metres (200 feet).

5.2.2 Navigational Aids

To support the Airport's all-weather capability, Toronto Pearson is equipped with electronic navigational and visual approach aids to provide both precision and non-precision approaches to all runways. The existing navigational and communications equipment at Toronto Pearson is listed below. The GTAA makes land available for the on-site navigational and communications equipment, however, Nav Canada owns, operates and maintains the equipment.

- An air traffic control tower located in the Infield, from which aircraft on the runways and taxiways and in the airspace in the immediate vicinity of the Airport are controlled. The tower offers controllers an eye-level elevation of 61.9 metres above ground level.
- Glide path equipment for each runway that provides electronic vertical guidance to approaching aircraft.

View of the Airside System from Airport South

View of the Airside System from Airport North

- Localizer equipment for each runway that provides electronic lateral/horizontal guidance to approaching aircraft.
- Two Doppler Very High Frequency Omni-Directional Range/Distance Measurement Equipment (DVOR/DME) stations, one located near Runway 05 and the other near Runway 06L; this equipment emits an electronic signal that is used by departing aircraft for navigational purposes.
- A Terminal Surveillance Radar (TSR) located near the west side of the Airport, just south of Runway 05-23, which is used by Air Traffic Control (ATC) staff to monitor airborne aircraft.
- Two Airport Surface Detection Equipment (ASDE) radar units used by air traffic control staff to monitor aircraft and vehicle traffic on the airport manoeuvering surface, located on the north and south ends of the Airport; the data from the two ASDE units is mosaiced to provide controllers a single display of all airport manoeuvering surfaces.
- Main and backup receiver sites used by ATC staff to receive voice communications from aircraft and vehicles.
- Main and backup transmitter sites used by ATC staff to transmit voice communications to aircraft and vehicles.
- Non-directional beacons (NDB) marking the final approach fix for a number of runways.
- DMEs collocated at either VOR or glide path sites, which provide slant range distance to equipped aircraft in support of instrument approaches.

All of Toronto Pearson's existing runways are equipped with the necessary lighting and navigational aid systems to facilitate nighttime operations as well as operations in Category I weather conditions.

Runway 05-23 and associated taxiways.

Additionally, Runways 06L and 05 are equipped with the appropriate lighting and navigational aid systems to accommodate landings under reduced visibility conditions known as Category II and Category IIIa conditions. All runways at Toronto Pearson have centreline lighting except for Runway 15R-33L.

In addition to the site-specific navigational aids described above, Toronto Pearson is home to the Toronto Area Control Centre (ACC), located in the Infield and operated by Nav Canada. The ACC is responsible for the control of aircraft across most of south-central Ontario except landing and departing aircraft in the immediate vicinity of an airport. Control of aircraft arriving at Toronto Pearson is transferred from the ACC to the Toronto Pearson control tower on the final approach to the assigned runway. Conversely, control of aircraft departing from Toronto Pearson is transferred from the Toronto Pearson control tower to the ACC shortly after the aircraft becomes airborne.

South ASDE Tower

5.2.3 Taxiways

The Airport's five runways are supported by an extensive system of taxiways, with a total length of some 40 kilometres. The current taxiway infrastructure has been developed incrementally over time in response to increased airside activity and the associated need to improve the efficiency of the airside system.

The taxiway system includes a number of high-speed exits on each runway to allow landing aircraft to exit the runways expeditiously plus taxiways paralleling the runways to move aircraft between the runways and the various passenger, cargo and hangar aprons.

A key element of the taxiway system is the provision of dual taxiways around the busy passenger terminal areas (Taxiways A, B, C and D). The dual taxiways allow bi-directional taxiway flows and independent taxiway routings for arriving and departing aircraft.

New taxiways constructed in recent years at Toronto Pearson have had low-visibility centreline lighting incorporated into the design. In addition, a program to replace taxiway edge lighting on older taxiways with preferred centreline lighting is essentially complete. As a result, the vast majority of taxiways at Toronto Pearson now have centreline lighting.

5.2.4 Aprons

A number of apron areas exist on the airside to accommodate the Airport's aircraft parking requirements. These include aprons associated with the passenger terminals for the unloading, loading and servicing of passenger aircraft; aprons associated with the cargo facilities for the unloading, loading and servicing of all-cargo aircraft; aprons associated with the airline hangars for the maintenance of aircraft; and aprons associated with the business aviation hangars for the unloading, loading and servicing of corporate jets.

The new passenger terminal apron built in conjunction with Terminal 1 had centreline lighting incorporated into the design of the apron taxilanes to facilitate aircraft operations during low-visibility conditions. In addition, a program to retrofit low-visibility centreline lighting on older apron taxilanes is nearing completion.

Aircraft traffic on the passenger terminal aprons is controlled by the GTAA from two apron control towers located on Terminal 1 and Terminal 3. The control of arriving aircraft is handed over from the Nav Canada control tower to the applicable GTAA apron control tower when the aircraft leaves the taxiway system and enters the terminal apron. Conversely, the control of departing aircraft is handed over from the GTAA apron

Nav Canada Air Traffic Controllers at Toronto Pearson

control tower to the Nav Canada control tower when the aircraft leaves the apron and enters the taxiway system.

5.2.5 Airside Roads

An extensive system of airside roads is available on the airfield to provide transportation routes between airport facilities for routine operational and maintenance purposes, and to facilitate rapid access for fire and rescue service vehicles. The main airside roads are shown in Figure 5-1, although many secondary airside roads also exist including those on the aprons and those providing access to navigational aid sites.

A key element of the airside road system is the tunnel located under Runway 15L-33R and Taxiways A, B and E. The four-lane tunnel allows for efficient vehicular transportation between the passenger terminal buildings on the east side of the Airport and the infield facilities, without the need to cross active runways or taxiways at grade. Users include buses transporting passengers between Terminals 1 and 3 and the Infield Terminal, catering trucks transporting meals from the infield flight kitchen to aircraft on the passenger terminal aprons and cargo tugs transporting cargo between aircraft on the passenger terminal aprons and the infield cargo facilities.

Another unique component of the airside road system is the emergency infield access road, which is closed under normal operations, but could provide backup groundside access to the infield area in the unlikely event that public access to the Infield along Britannia Road East becomes temporarily unusable.

5.2.6 Deicing/Anti-icing Facilities

Deicing of aircraft prior to departure to remove any frost, snow or ice contamination from critical surfaces, and anti-icing to protect the aircraft from further contamination is required to ensure the safe operation of aircraft. Frost deicing, which requires the application of relatively low volumes of deicing fluid, is undertaken on the aprons of Terminal 1 and Terminal 3, on one of the north business aviation area aprons and at the Central Deicing Facility located in the infield area of the Airport. Operations during precipitation conditions (snow or freezing rain) require the application of both deicing and anti-icing fluids and are carried out only at the Central Deicing Facility. All deicing operations at Toronto Pearson employ proven truck-based technology.

As shown in Figure 5-2, the Central Deicing Facility consists of six pads and an adjoining support area. Each pad can accommodate the deicing of two narrow-body aircraft in a side-by-side configuration, or a single wide-body aircraft, including the capability to accommodate Code F sized aircraft such as the new Airbus A380. The facility can deice up to 12 narrow-body aircraft or six wide-body

North ASDE Tower

Terminal Surveillance Radar

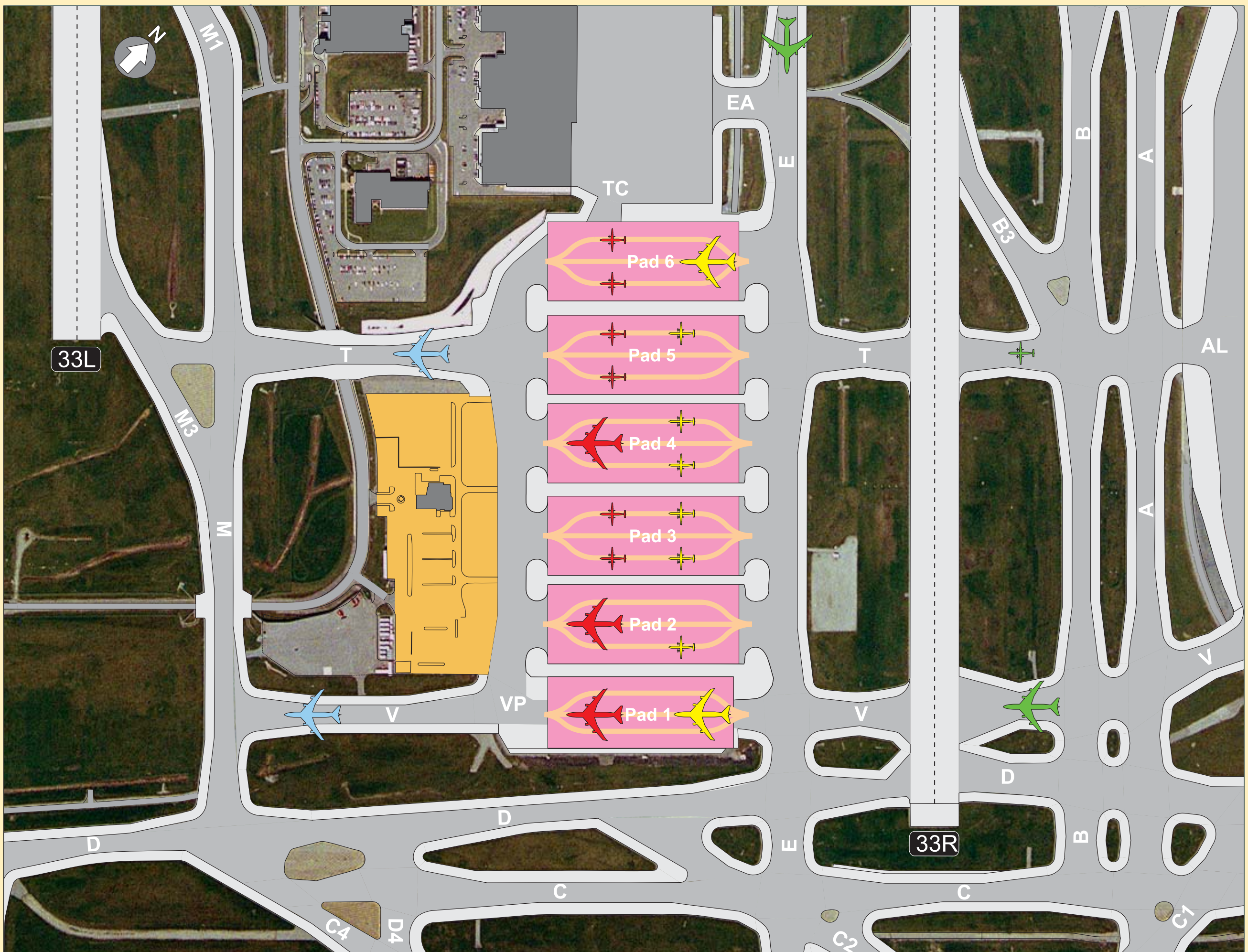


FIGURE 5-2 **CENTRAL DEICING FACILITY**

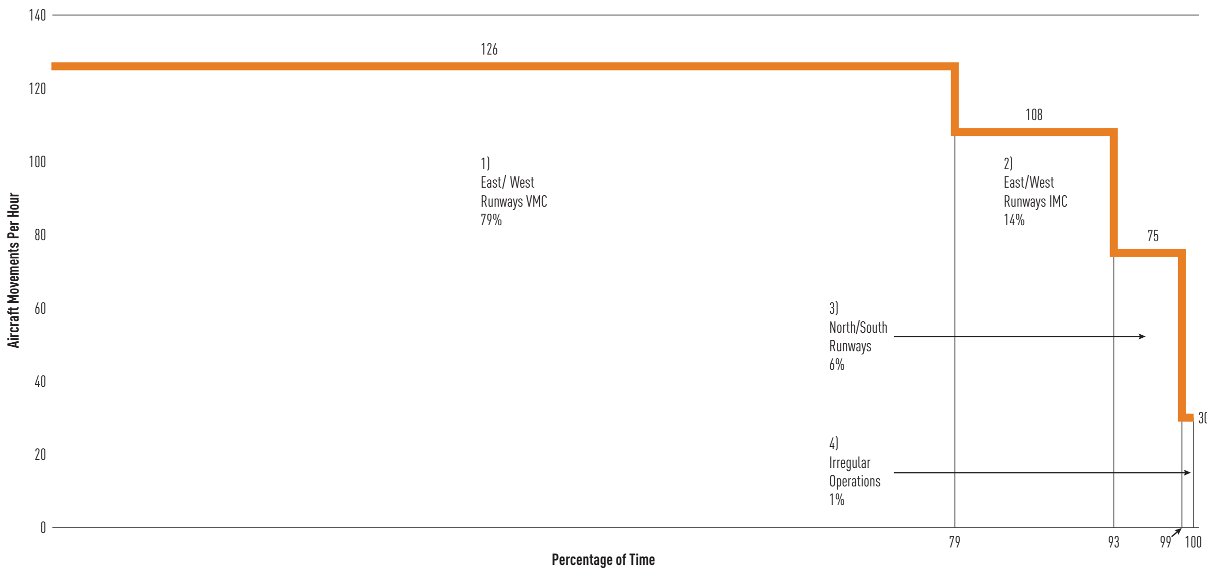
aircraft simultaneously. In addition, each pad provides an equivalent amount of staging area immediately behind the deicing positions to expedite the movement of the next aircraft into deicing position.

Figure 5-2 illustrates an east-to-west flow of aircraft through the Central Deicing Facility, which is the most common direction of operation. Under certain operational circumstances, however, the flow is reversed with the deicing and staging positions being interchanged. The Central Deicing Facility support area immediately west of the pads contains new glycol storage tanks, underground spent glycol storage tanks, training facilities, glycol recycling facilities, a deicing vehicle maintenance facility and an "ice house" from which Central Deicing Facility operations are controlled. The operation of the Central Deicing Facility has been contracted to Servisair by the GTAA.

The Central Deicing Facility was designed and constructed with an extensive glycol recovery system to minimize the environmental impacts of spent glycol runoff.

FIGURE 5-3

Capacity Coverage for the Existing Five-Runway System



5.2.7 Capacity of the Existing Airside System

The airside capacity of Toronto Pearson is determined to a large extent by factors outside the control of the GTAA. For example, the airside capacities presented in this chapter are based upon current Transport Canada regulations and Nav Canada air navigation technology and practices. Should regulatory, technological or procedural changes occur in the future, the airside capacities reflected in this Master Plan may need to be re-examined.

A capacity coverage chart is a tool commonly used to quantify the overall capacity of an airport's airside system. The capacity coverage chart reflecting the existing five-runway system at Toronto Pearson is shown in Figure 5-3. The chart illustrates the hourly capacities available at the Airport under different wind and weather situations (plotted on the vertical axis) and the percentage of time each is typically available (plotted on the horizontal axis).

The capacity coverage chart for Toronto Pearson includes four main types of runway operations, as described in the following sections.

East/West Runway Operations – Visual Meteorological Conditions: The first type of runway operation corresponds to the simultaneous use of the Airport's three east/west runways under visual meteorological conditions (VMC), when the weather is such that pilots can make visual reference to the ground for navigational purposes.

Runways 06L-24R and 06R-24L do not have sufficient separation between them to permit independent operations. As a result, arrivals are assigned to one of the runways and departures to the other. For both noise mitigation and operational reasons, arrivals are assigned to the outer runway

Aircraft taxiing to Runway 06L via Taxiway Delta adjacent to Etobicoke Creek

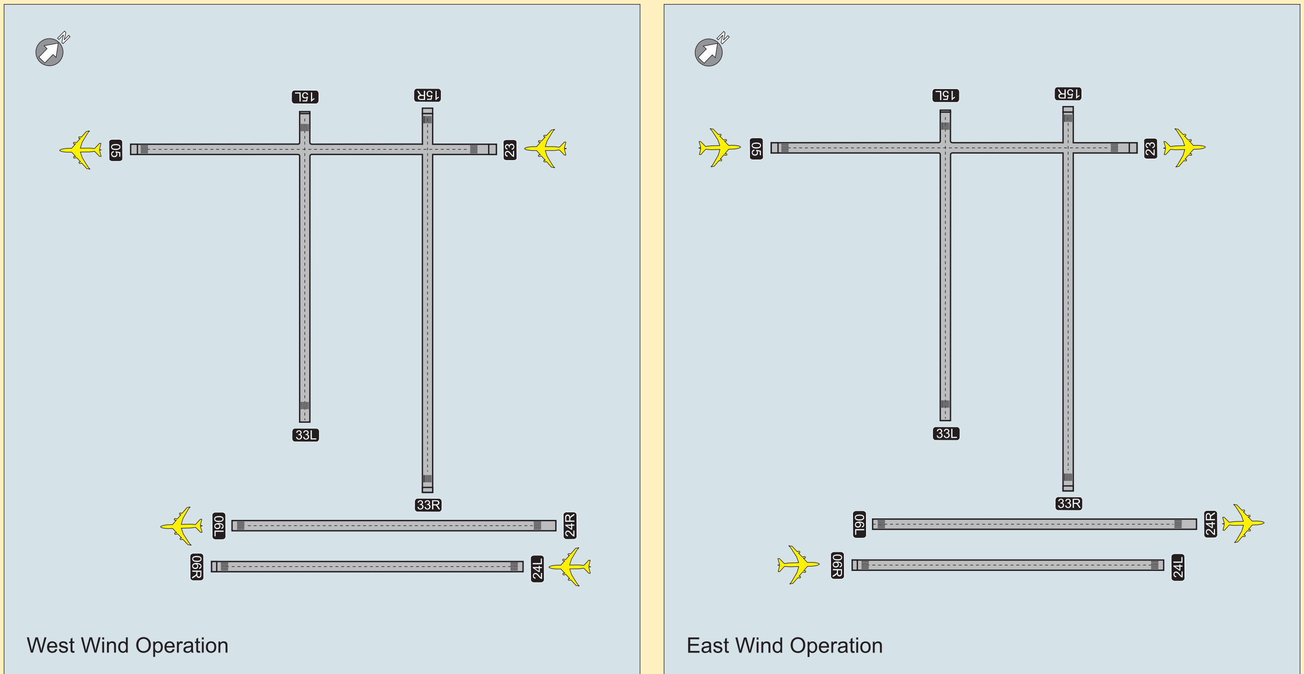


FIGURE 5-4 **EAST/WEST RUNWAY OPERATIONS**

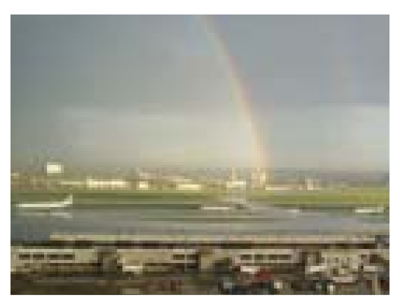
(06R-24L) and departures are assigned to the inner runway (06L-24R). Runway 05-23 is sufficiently separated from the southern runway complex to be operated independently, serving a mixture of arrivals and departures.

This type of runway operation is shown in Figure 5-4. Aircraft need to fly into the wind when landing and taking off. As a result, the first diagram applies to a westerly wind situation with arrivals on Runways 23 and 24L, and departures on Runways 23 and 24R. The second diagram applies to an easterly wind situation with arrivals on Runways 05 and 06R, and departures on Runways 05 and 06L.

Through GTAA computer simulations, it was determined that based on the anticipated aircraft fleet mix at Toronto Pearson and a balanced demand of arrivals and departures, this type of operation has a capacity of approximately 126 aircraft movements per hour, including 56 operations on Runway 05-23 and 70 operations on the closely spaced parallel runways, Runways 06L-24R and 06R-24L. This capacity exceeds current demand levels at Toronto Pearson. An analysis of weather data suggests that this type of operation tends to be available approximately 79 per cent of the time.

East/West Runway Operations – Instrument Meteorological Conditions: The second type of operation also corresponds to the use of the three east/west runways in the same manner, but under instrument meteorological conditions (IMC) that occur when visibility is such that instrumentation, rather than visual reference, is required for navigation. Under these conditions, larger separations between aircraft are required compared to the separations applied under visual meteorological conditions.

Based on GTAA computer simulations, the capacity of the three east/west runways decreases to approximately 108 aircraft movements per



Aircraft taxiing to departure runway

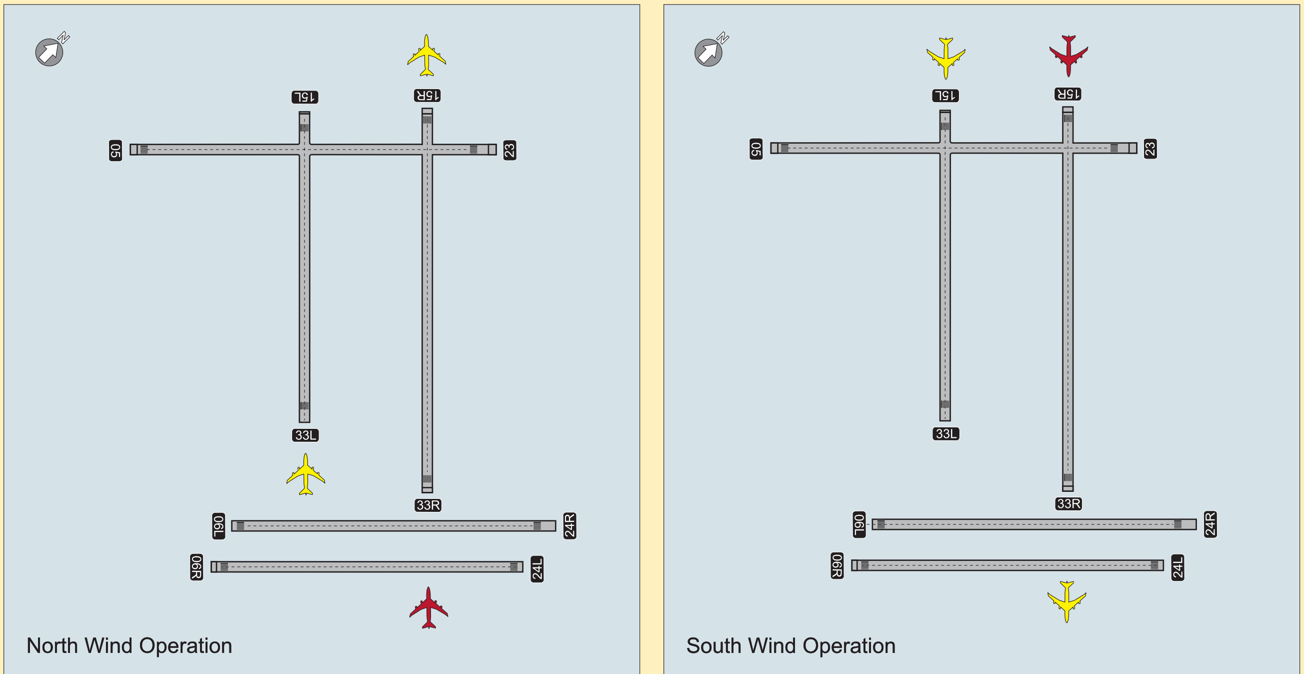


FIGURE 5-5 NORTH/SOUTH RUNWAY OPERATIONS

Primary Arrival and Departure Runways — Arrival Off-load Runway

hour during instrument meteorological conditions, including 48 operations on Runway 05-23 and 60 operations on the closely spaced parallel Runways 06L-24R and 06R-24L. This type of operation tends to occur approximately 14 per cent of the time.

Since using the east/west runways offers the highest capacity, these first two types of operations are preferred during peak time periods. However, since demand does not currently require the simultaneous use of all three east/west runways on a regular basis, air traffic control sometimes utilizes only two of the east/west runways, resulting in a lower capacity than presented in the capacity coverage chart.

Given that the purpose of the capacity coverage chart is to quantify the maximum capacity available under given wind and weather conditions, it is not necessary to reflect these lower capacity configurations in the chart. As air traffic demand grows over time, the frequency of using all three east/west runways simultaneously will increase toward the values given in the capacity coverage chart.

North/South Runway Operations: The third type of operation reflected in the capacity coverage chart pertains to the use of the north/south runways when strong cross-wind conditions preclude the use of the east/west runways. Similar to Runways 06L-24R and 06R-24L, Runways 15L-33R and 15R-33L do not have sufficient separation to permit independent operations. As a result, arrivals are assigned to one runway and departures to the other. Arrivals, which require less runway length than departures, are typically assigned to 15R-33L, the shorter runway, and departures are typically assigned to 15L-33R, the longer runway. Under this type of operation, it is not uncommon for arrivals of heavier aircraft to be off-loaded onto 15L-33R to provide a longer landing distance.

The resulting north/south runway operation is shown in Figure 5-5. The first diagram shows the operations that would occur under strong north wind conditions with 33L being used as the primary

Terminal Apron Areas and Dual Taxiway System

arrival runway, and 33R being used for departures and some possible off-loading of arrivals from 33L. The second diagram shows the operations that would occur under strong south wind conditions with 15R being used as the primary arrival runway, and 15L being used for departures and some possible off-loading of arrivals from 15R.

Through an analysis of historical aircraft movement data, the capacity of the north/south runways was found to be 75 movements per hour while the frequency of use tends to be approximately five per cent of the time in the 33 direction and approximately one per cent of the time in the 15 direction for a total of approximately six per cent of the time.

Irregular Operations: The final type of operation shown in the capacity coverage chart is termed "irregular" operations, which includes operational conditions that typically result in an airside throughput significantly below the other three more "regular" types of operations. Irregular operations do not relate to any specific runway configuration, but rather could involve the use of any runway(s) depending on operational circumstances.

There are four primary types of events that comprise irregular operations:

- Snowstorms, that require the periodic closure of runways and taxiways for snow removal and the need to deice/anti-ice aircraft prior to departure.
- Thunderstorms, that result in an inability to load, unload or service aircraft on the apron due to unsafe working conditions.
- Poor visibility conditions, that limit operations to the runways and to aircraft with appropriate navigational equipment for such conditions.
- Other ad hoc circumstances that require the temporary closure of airside infrastructure, such as during emergency situations.

Based on an analysis of historical aircraft throughput data associated with irregular operations, the average throughput achieved during these types of events is approximately 30 movements per hour and these conditions tend to occur approximately one per cent of the time.

Average Hourly Capacity: Using the hourly capacity and frequency information from each of the four types of operations in the capacity coverage chart, Toronto Pearson's average hourly airside capacity can be calculated as follows:

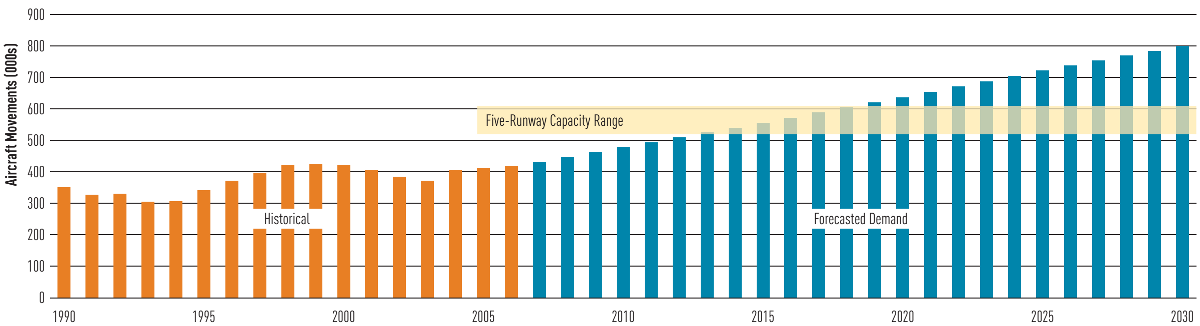
(79% x 126) + (14% x 108) + (6% x 75) + (1% x 30) = 119 aircraft movements per hour

TABLE 5-2 MAXIMUM AND PRACTICAL ANNUAL CAPACITIES FOR THE EXISTING FIVE-RUNWAY SYSTEM

Hour Group	Time Period(s)	Number of Hours		Typical Demand		Average Hourly Capacity		Planning Day Capacity
Peak	6:30 a.m.– 9:29 a.m. 2:30 p.m.– 9:29 p.m.	10	x	1.00	x	119	=	1,190
Off-Peak	9:30 a.m.– 2:29 p.m.	5	x	0.80	x	119	=	476
Transitional	9:30 p.m.– 12:29 a.m.	3	x	0.55	x	119	=	196
Night	12:30 a.m.– 6:29 a.m.	6		Capacity defined by nighttime operations budget				55
				Planning Day Capacity				1,917
							x	320
				Maximum Annual Capacity (Rounded)				**610,000**
							x	85%
				Practical Annual Capacity (Rounded)				**520,000**

FIGURE 5-6

Aircraft Movements and Five-Runway Capacity



Planning Day Capacity: Since the demand for air travel is not constant over the 24-hour day, it would not be reasonable to multiply this average hourly capacity by 24 to obtain a daily capacity of the airside system. Instead, as shown in Table 5-2, the day has been divided into four groups, namely peak hours, off-peak hours, transitional hours (transitioning into the night period), and night hours.

During the peak hours, it is assumed that the Airport could operate at the maximum capacity that wind and weather conditions allow, as reflected in the average hourly capacity of 119 aircraft movements per hour. However, during the off-peak and transitional hours, a "demand factor" is used to reduce the expected hourly throughput in recognition of the lower demand levels that typically exist during those portions of the day relative to peak period demand. The capacity of the nighttime hours has been set in accordance with the annual nighttime operations budget arrangement between the GTAA and Transport Canada, as explained in Chapter 13.

The sum of the resulting calculations for each of the four groups of hours provides the Airport's airside capacity on a "planning day", which reflects a busy summer weekday.

Annual Capacity: Since the demand for air travel is typically lower on weekends than on weekdays, and lower in the fall, winter and spring seasons than in the summer, the multiplication of the planning day capacity by 365 days per year would yield an unrealistically high annual airside system capacity. Instead, analysis of weekday versus weekend and seasonal traffic data at Toronto Pearson suggests that a planning day to annual factor of 320 is more appropriate, generating a maximum annual airside capacity of 610,000 aircraft movements.

Although the maximum annual capacity calculated above is an attainable level of throughput, significant levels of congestion and delay would occur in the peak periods to achieve that traffic volume. For this reason, the attainment of approximately 85 per cent of the maximum annual capacity is considered to be the Airport's practical annual capacity offering a better level of service to airport users. The practical annual airside capacity for the existing five-runway system is approximately 520,000 movements.

The maximum and practical capacities can be used to create a range of annual airside system capacity with the maximum capacity value representing the upper limit of the range and the practical capacity value representing the lower limit of the range. This annual airside system capacity range for the Airport's existing five-runway system is depicted by the horizontal band in Figure 5-6.

5.2.8 Demand/Capacity Assessment

Historical annual aircraft movement levels at Toronto Pearson up

Terminal 1 Apron Control Tower

to 2006 are plotted in Figure 5-6 in the vertical bars. Aircraft movement levels at the Airport have typically included periods of strong growth followed by weaker periods of declining aircraft movements, resulting in an overall upward trend. A general description of this historical pattern over the past two-and-a-half decades and some of the reasons underlying the fluctuations are provided below.

- Following strong growth in the 1980s in which the number of aircraft movements increased 41 per cent, a slowdown in the economy in the early 1990s resulted in a decline in activity to 305,000 in 1993, a decrease of approximately 13 per cent over three years.
- After this decline, Toronto Pearson experienced another significant growth of approximately 39 per cent over the span of six years, in which the number of aircraft movements peaked in 1999, at 425,000 movements.
- The next decline in aircraft movements was the result of several events including the merger of Air Canada and Canadian Airlines, which removed excess capacity from the domestic market, as well as the terrorist attacks on September 11, 2001 and the SARS outbreak, which both temporarily decreased the demand for air travel. This decline continued until 2003 when the number of aircraft movements dropped to 372,000, a decrease of 13 per cent over four years.

Central Deicing Facility

- More recently, Toronto Pearson has experienced yet another growth period in aircraft movements. In 2006, activity increased to 418,000 aircraft movements, a growth of approximately 12 per cent over the past three years.

Transport Canada's forecast for aircraft movements at Toronto Pearson from 2007 to the year 2025 is also shown in Figure 5-6 in the vertical bars.

Based on the Transport Canada aircraft movement forecasts, the practical annual capacity of the five-runway system of 520,000 aircraft movements could be reached in approximately 2013, while the maximum annual capacity of 610,000 aircraft movements could be reached in approximately 2019. Therefore, airside congestion could begin to develop in the 2013-2019 time period, and depending upon the level of delay airport users are willing to accept, additional airside infrastructure could be required sometime after 2013. Ongoing monitoring of traffic demand and airside congestion will be required to determine the need for, and timing of, new airside facilities.

5.3 FUTURE AIRSIDE DEVELOPMENT

5.3.1 Future Runway 05R-23L

An environmental assessment was conducted in 1991-1992 for the addition of three new runways and supporting taxiways and navigational aids at Toronto Pearson, in order to meet forecast demand. The environmental assessment encompassed the construction of the Airport's two newest runways, namely Runway 15R-33L completed in 1997 to alleviate a capacity shortfall in the north/south direction of operation, and Runway 06R-24L completed in 2002 to increase the capacity of the Airport in the primary (east/west) direction of operation.

The third runway covered by the environmental assessment is another east/west runway, to be designated 05R-23L. Runway 05R-23L would be located parallel to and 408 metres south of existing Runway 05-23, as shown in Figure 5-7. Existing Runway 05-23 would be renamed 05L-23R prior to the commissioning of planned Runway 05R-23L. Planned Runway 05R-23L would be the final runway that could be accommodated on the airport site.

Since environmental approval has already been obtained for planned Runway 05R-23L, it could be constructed at the discretion of the GTAA when warranted by demand. A lead time of approximately three to four years would be required to design, construct and commission the new runway.

FIGURE 5-7 **POTENTIAL FUTURE AIRSIDE DEVELOPMENT**

- Airport Boundary
- Airside Road
- Groundside Road
- Exit C1 Realignment
- 15R - 33L Taxiway Enhancements
- North Deicing Facility
- Taxiway Echo Extension
- Runway 33R Exit

RUNWAY 05R-23L PROJECTS

- Runway 05R-23L
- Taxiways
- Airside Road
- Etobicoke Creek Realignment

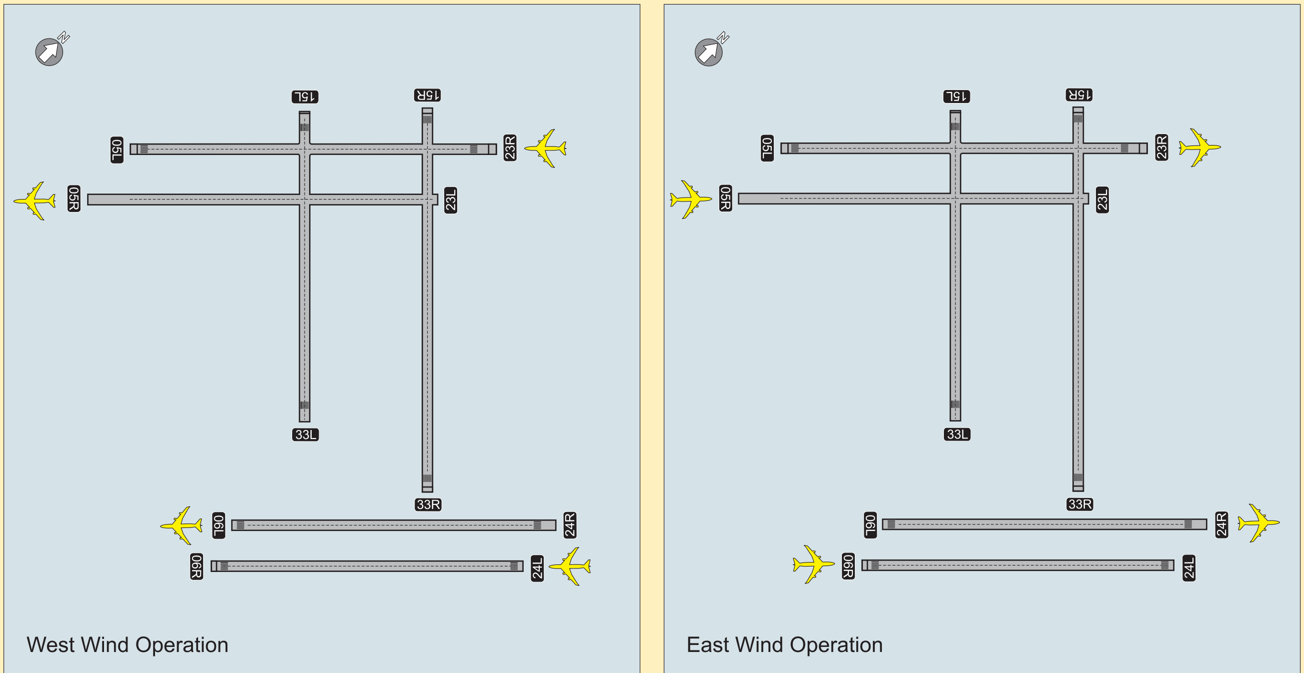


FIGURE 5-8 **SIX-RUNWAY OPERATIONS**

Two parcels of land on the west side of the airport property were acquired by the GTAA in order to protect for the construction and operation of Runway 05R-23L and associated navigational aids.

Construction of Runway 05R-23L would require the removal of the existing TSR radar facility. Nav Canada would identify replacement requirements at that time, including an investigation of potential replacement technologies. Figure 5-7 identifies an alternative TSR site west of Runway 15R-33L in the Etobicoke Creek Valley that has been selected by Nav Canada, and is being reserved by the GTAA for this purpose.

A section of Etobicoke Creek will also require relocation to accommodate Runway 05R-23L. It is anticipated that the new creek bed would be designed to meander, to enhance the quality of the aquatic habitat.

Similar to the existing pair of closely spaced parallel runways at the southern end of the airfield (06L-24R and 06R-24L), existing Runway 05-23 and planned Runway 05R-23L would operate as a dependent parallel complex with arrivals on one runway and departures on the other. However, due to the location of the cargo terminal facilities near the eastern end of planned Runway 05R-23L, the new runway would be utilized only for takeoffs to the west and arrivals from the west.

As shown in Figure 5-8, in the 23 direction of operation, new Runway 23L would accommodate departures while existing Runway 23R (currently designated 23) would accommodate arrivals. Occasionally, departing aircraft requiring more takeoff length than is available on Runway 23L could be off-loaded onto Runway 23R between arriving aircraft. In the 05 direction of operation, planned Runway 05R would accommodate arrivals while existing Runway 05L (currently designated 05) would accommodate departures. Operations on Runways 06L-24R and 06R-24L would remain unchanged from the current situation.

Supporting taxiway facilities required for planned Runway 05R-23L would not be as extensive as for the other runways at the Airport due to the operating restrictions described above.

Deicing Operations

Taxiway construction would include the completion of Taxiway N and high speed exits at the eastern end of the runway to be used by aircraft landing on Runway 05R, and the construction of a taxiway connection to Taxiway H near the western end of the runway to be used to exit the runway in the event of an aborted departure on Runway 23L.

The operating restrictions on the use of the planned runway would also limit the requirements for navigational aids to a localizer and glide path for arrivals on Runway 05R.

Planned Runway 05R-23L would have a landing distance of 2,718 metres (8,919 feet) available in the 05 direction. In the 23 direction, a 300 metre (984 feet) stopway and clearway would be provided at the western end of the runway in order to increase the takeoff distance available to 3,018 metres (9,903 feet).

As a result of the close proximity of planned Runway 05R-23L to existing Runway 05-23, potential changes to flight paths and associated noise impacts on the west end of the runway would be minimized. Given the operational restrictions imposed on planned Runway 05R-23L by the obstruction on the eastern end of the runway, the flight paths east of the Airport would not change.

5.3.2 Other Airside Development

The addition of planned Runway 05R-23L and associated facilities would be the final major element of the Toronto Pearson airside system. However, where warranted, consideration will be given to implementing other airside enhancements to improve the efficiency of airport operations, which in turn reduces fuel burn and air emissions, or to meet any future regulatory changes. Given the advanced state of maturity of the airport site, other potential airfield enhancements are likely to be relatively modest in nature in comparison to the addition of Runway 05R-23L. A number of possible airfield enhancements are described below, and conceptually illustrated in Figure 5-7.

- Existing runway exit C1 on Runway 06L could be realigned to convert it into a high-speed runway exit. This improvement would reduce the average runway occupancy time for aircraft landing on Runway 06L and enhance safety by simplifying the taxiway network.
- The linking of Taxiways F and M to provide a full-length parallel taxiway for Runway 15R-33L could be provided to improve airside access to the infield facilities and to minimize the need to use Runway 15R-33L as a taxiway. In conjunction with the linking of Taxiways F and M, two new high-speed exits could be considered for Runway 15R-33L to decrease the distance that smaller arriving aircraft would have to taxi on the runway to reach an exit, thereby decreasing the average runway occupancy time.
- An area at the north end of the infield area has been reserved for a possible second deicing facility to supplement the existing Central Deicing Facility, if warranted in the future. A deicing facility with three deicing pads and associated support facilities, roughly half the size of the existing Central Deicing Facility, could be accommodated at this site. Continued monitoring of throughput at the existing Central Deicing Facility will be required as traffic demand increases to determine if a second deicing facility is required.

Air Traffic Control Tower and Infield tunnel entrance (background)

- Taxiway Echo could be extended towards the north to Taxiway Juliet to facilitate the movement of aircraft from the Central Deicing Facility to Runway 15L.
- A high-speed exit could be considered on the west side of Runway 33R for arriving aircraft destined for the infield area to decrease their average runway occupancy time.
- The airside road system around the circumference of the airfield could be completed by connecting the airside road at the west end of Runways 06L and 06R to the airside road adjacent to the remote receiver. Such a connection would allow airport staff to travel between the north and south airside areas on the west side of the Airport without the need to exit and re-enter the secure airside area.

Other possible airfield enhancements that are not illustrated in Figure 5-7 include:

- Taxiway access to the recently acquired Boeing lands may be required, depending on the type of future airport development undertaken on that site, as discussed further in Chapter 14.
- A number of taxiway fillets at key taxiway intersections could be widened and shoulders added to runways to accommodate future Airbus A380 operations, as is discussed further in Section 5.3.3.

In all cases, further assessment will be required to determine the need for and the timing of additional airside infrastructure.

5.3.3 Airbus A380 Readiness

The world's largest commercial passenger aircraft, the new Airbus A380 entered service in October 2007. Although no carrier has stated an intention to operate this aircraft at Toronto Pearson yet, the GTAA considered the operational requirements of the A380 in its airport redevelopment plans to ensure that the Airport will have the ability to accommodate the aircraft when required without major reconstruction. However, a few modifications to Toronto Pearson's infrastructure would be considered as outlined below.

All runways at Toronto Pearson are wide enough to accommodate the A380. In addition, paved shoulders that are required for the A380 have already been added to Runway 05-23, and are currently being added to Runway 06L-24R as part of a rehabilitation of the runway. Paved shoulders could be added to other runways in the future as required.

Runway 05-23 has been identified as the preferred runway for A380 operations as adequate lateral separation exists between it and parallel Taxiways H and J to accommodate the aircraft without restrictions. However, when the A380 taxis between Runway 05-23 and the terminals, operations on adjacent taxiways would be restricted to specific aircraft sizes. Although the turning radius of the A380 is smaller than the Airbus A340-600, which already operates at Toronto Pearson, a limited number of taxiway fillets could be widened at key taxiway intersections for ease of manoeuverability.

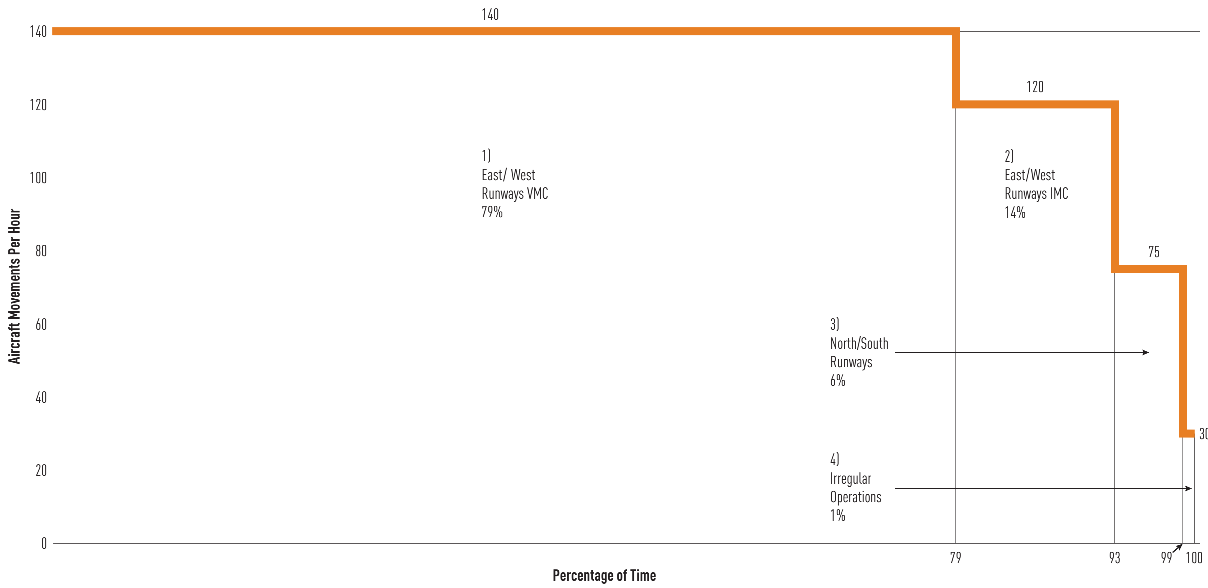
As will be discussed further in Chapter 6, Terminal 1 and its associated apron has been designed to support A380 operations on two of the Hammerhead F gates. One of the gates has been fully equipped to handle the A380, while the second gate would require some modifications prior to accommodating the A380. Terminal 3 and its associated apron could also handle the A380, if required, on two of the gates on Pier C, with some modifications.

5.3.4 Capacity of the Ultimate Airside System

Figure 5-9 provides the capacity coverage chart pertaining to the ultimate six-runway system. The four types of runway operations that are currently used under the existing five-runway system will also be applicable to the future six-runway layout, and the frequencies of use would also remain unchanged. Therefore, the only changes required to the capacity coverage chart to reflect the addition of the sixth runway relate to

FIGURE 5-9

Capacity Coverage for the Six-Runway System



the hourly capacities of the first two types of operations involving the use of the east/west runways, which have been obtained through computer simulations.

The capacity of the four east/west runways under the first type of operation, visual meteorological conditions, is estimated to be 140 movements per hour. Under the second type of operation, instrument meteorological conditions, the capacity of the four east/west runways is estimated to be 120 movements per hour.

The capacities of the third and fourth type of operation would be unchanged from the five-runway system because they are affected by the north/south runways and weather/wind conditions rather than the number of east/west runways.

Applying the hourly capacities associated with the simultaneous operation of the four east/west runways, Toronto Pearson's average hourly airside capacity for the six-runway system would be calculated as follows:

(79% x 140) + (14% x 120) + (6% x 75) + (1% x 30) = 132 aircraft movements per hour

Following the same method as was used in Section 5.2.7, this average hourly capacity of 132 can be translated into a maximum achievable annual capacity of 680,000 and a practical annual capacity of 580,000 as shown in Table 5-3.

5.3.5 Demand/Capacity Assessment

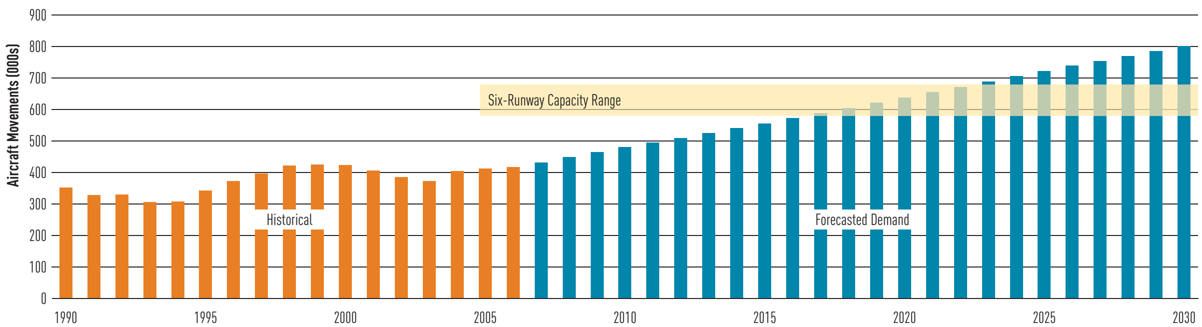
The resulting annual capacity range for the six-runway system is

TABLE 5-3 MAXIMUM AND PRACTICAL ANNUAL CAPACITIES FOR THE ULTIMATE SIX-RUNWAY SYSTEM

Hour Group	Time Period(s)	Number of Hours		Typical Demand		Average Hourly Capacity		Planning Day Capacity
Peak	6:30 a.m.– 9:29 a.m. 2:30 p.m.– 9:29 p.m.	10	x	1.00	x	132	=	1,320
Off-Peak	9:30 a.m.– 2:29 p.m.	5	x	0.80	x	132	=	528
Transitional	9:30 p.m.– 12:29 a.m.	3	x	0.55	x	132	=	218
Night	12:30 a.m.– 6:29 a.m.	6		Capacity defined by nighttime operations budget				62
				Planning Day Capacity				2,128
							x	320
				Maximum Annual Capacity (Rounded)				**680,000**
							x	85%
				Practical Annual Capacity (Rounded)				**580,000**

FIGURE 5-10

Aircraft Movements and Six-Runway Capacity



illustrated in Figure 5-10. Based on Transport Canada's current aircraft movement forecasts, the practical capacity of 580,000 aircraft movements would be exceeded in approximately 2017 and the maximum capacity of 680,000 aircraft movements would be exceeded in approximately 2023. Therefore, airside congestion would begin to develop in the 2017-2023 time period.

5.4 BALANCING AIRSIDE FACILITIES WITH PASSENGER TERMINAL AND GROUNDSIDE FACILITIES

It is important that the airside facilities at an airport are planned and developed in balance with the passenger terminal and groundside facilities to ensure that the capacity of one sub-system is not increased to a level that cannot be sustained by the others.

To facilitate further discussion on this balancing issue later in the document, the Airport's ultimate annual airside capacity, which has been defined only in terms of aircraft movements thus far in this chapter, is converted into an approximate passenger volume for comparison to terminal and groundside development plans.

Based on future traffic projections, it is anticipated that when traffic demand approaches the capacity of the six-runway system, approximately 88 per cent of aircraft movements at Toronto Pearson will be passenger aircraft using the passenger terminals. The remaining 12 per cent of aircraft movements would be comprised of cargo freighter and business aviation aircraft that do not use the passenger terminals.

It is also estimated that given the diverse range of markets served by Toronto Pearson and the resulting mix of aircraft sizes using the Airport, the passenger aircraft will carry an average of approximately 90 passengers per aircraft at that time. As calculated in Table 5-4, the annual six-runway system capacity range derived in Section 5.3.4 equates to a range of approximately 46 million to 54 million passengers per year. These passenger volumes will be discussed further within the context of the passenger terminal and groundside development plans later in this document.

TABLE 5-4 SIX-RUNWAY AIRSIDE CAPACITY IN TERMS OF PASSENGERS

Annual Capacity	Annual Aircraft Movements		Proportion of Passenger Carrying Aircraft		Passenger Carrying Aircraft Movements		Average Number of Passengers per Aircraft		Annual Passenger Capacity (Millions)
Practical	580,000	x	88%	=	510,400	x	90	=	45.9
Maximum	680,000	x	88%	=	598,400	x	90	=	53.9

5.5 OPPORTUNITIES TO MAXIMIZE AIRSIDE CAPACITY

The airside capacities quantified in this chapter are dependant upon a number of assumptions and variables. Given that the results of the demand/capacity assessment indicate that Toronto Pearson will reach its airside capacity within the planning horizon of this

Airbus A380

Master Plan, a discussion on potential means of increasing the airside capacity beyond the levels identified is warranted.

5.5.1 Daily Traffic Peak Spreading

The airside capacity calculations assume that the Airport operates at full capacity for a total of ten hours at the beginning and end of the typical business day. It is also assumed that the Airport operates at a lower throughput level of 80 per cent and 55 per cent of full capacity during the five off-peak hours and three transitional hours respectively, in recognition of the natural daily traffic patterns that are inherent in air travel demand.

This calculation already implies a significant degree of peak spreading, or traffic leveling during the ten peak hours of the day. However, further spreading of traffic into the non-peak portions of the day would increase the aircraft and passenger throughput. A shift in the daily traffic profile could be proactively achieved through the strict limitation and control of aircraft slots per hour, thereby forcing airlines that are not able to acquire a sufficient number of slots at preferred times to use non-peak slots. Alternatively, in the absence of a traffic management system, when traffic demand grows to the point of exceeding available capacity in the peak hours, traffic would incur delays and be pushed out into the non-peak periods. In either case, the end result is that over time, an increasing number of passengers would be forced to travel at non-preferred times of the day, use alternate airports, alternative modes of transportation, or not travel. Regardless of the market response, the result would be a significant economic and social cost.

As an example of the overall potential impact on capacity, an increase in the traffic demand during the off-peak and transitional hours to 90 per cent and 75 per cent of full capacity respectively, which would represent a very significant travel pattern shift, would increase the annual passenger capacity of the airside system by approximately 3-4 million passengers. While such a shift in traffic would be theoretically possible, and could be implemented as a short-term measure in the absence of alternative aviation capacity, it would clearly not be an optimal long-term solution, and, depending on market response, may not be successful.

5.5.2 Weekly/Seasonal Traffic Patterns

The planning day airside capacity, reflecting a busy summer weekday, has been converted into an annual capacity through the application of a planning day to an annual factor of 320. This factor is lower than 365 due to the fact that traffic demand is typically lower on weekends than on weekdays and lower in the fall, winter and spring seasons than in the summer.

Given the relatively inflexible travel patterns associated with the typical business week and time of year vacation planning, it is unlikely that a significant proportion of passengers would be willing to alter their weekly or seasonal travel patterns on a sustained basis in response to congestion at the Airport. As a result, this is not considered to be a viable means of increasing passenger capacity at Toronto Pearson.

5.5.3 Increased Nighttime Operations

The airside capacity calculations assume that the number of aircraft operations during the nighttime restricted period (12:30 a.m. to 6:29 a.m.) will increase in proportion to the overall increase in passenger traffic at the Airport, consistent with the Airport Authority's annual nighttime operations budget arrangement with Transport Canada. As a result, the calculations already incorporate a significant future increase in nighttime traffic. Further increases in the utilization of available capacity in the nighttime period would increase the overall airport capacity.

However, the impact of further increases in nighttime operations on a number of important issues would need to be considered, including the noise impact on the surrounding communities, the size of the Airport's noise contours in relation to the Airport Operating Area and the impact on airport-community relations. In addition, changes to the annual nighttime operations budget arrangement with Transport Canada would be required.

Even if the above issues could be resolved, it is very questionable whether significant numbers of passengers would be willing to fly during the restricted hours. Although there may be some traffic segments that could be somewhat amenable to flying during the restricted hours, such as vacation charter flights or long-haul flights that currently have difficulty complying with nighttime restrictions at the Airport at the opposite end of the route, it is unlikely that a large overall increase in passenger volumes could be achieved on a sustained basis.

5.5.4 Off-loading Business Aviation Traffic

The airside capacity calculations have assumed that 88 per cent of

the aircraft at Toronto Pearson will be passenger carrying aircraft in the long term, with cargo freighter and business aviation aircraft comprising the remaining 12 per cent.

An increase in the proportion of passenger carrying aircraft through the off-loading of business aviation aircraft to other area airports would translate into a higher airside passenger capacity. Potential mechanisms that could be employed to off-load business aviation traffic include pricing strategies and other demand management techniques.

For every 1 per cent increase in the proportion of passenger carrying aircraft, the airside passenger capacity would increase by approximately 0.5 million passengers. However, it must be noted that only the off-loading of business aviation traffic during the peak hours would increase the passenger capacity, as the operation of business aviation aircraft during non-peak times when surplus capacity exists does not limit passenger aircraft activity.

The relatively modest potential increase in passenger volumes that could be achieved through the off-loading of business aviation traffic to other airports would need to be assessed against a number of other considerations when demand nears the Airport's capacity. These other considerations would include the importance of access to Toronto Pearson for the business aviation community, the availability and cost of alternative airport facilities, and the investment in business aviation facilities at Toronto Pearson. Therefore, while modest passenger capacity increases are possible through the off-loading of business aviation aircraft, no definitive conclusions should be drawn at this time.

5.5.5 Larger Aircraft

The airside capacity calculations have assumed that the passenger carrying aircraft at Toronto Pearson in the long run will carry an average of 90 passengers, representing a modest increase from the current average. This assumes that the trend towards smaller regional jets over the past 10-15 years will eventually reverse as the Toronto Pearson market matures and the Airport begins to become capacity constrained. It should also be noted that new aircraft types such as the Airbus A380 and the Boeing 787 have already been taken into consideration in the calculations.

A further increase in the long-term average number of passengers per aircraft would translate into a higher airside passenger capacity. For example, an increase to 100 passengers per aircraft would translate into an annual capacity increase of 5-6 million passengers. However, given the long typical life cycle of aircraft, the average aircraft size at Toronto Pearson in 2020 will be largely determined by aircraft fleet replacement decisions made by the air carriers many years earlier. In addition, airlines plan their aircraft fleet within the context of their overall route network, and as a result, the anticipated operating environment at any one specific airport is likely to have a limited impact on the overall fleet.

Therefore, the onset of congestion at Toronto Pearson in the long term is unlikely to trigger a fundamental change in the overall aircraft size operating at the Airport. While capacity gains are possible through the operation of larger aircraft, it must be recognized that the GTAA has little opportunity to influence this variable.

5.5.6 Air Navigation Services

The hourly airside capacities quantified in this chapter are based on existing Transport Canada regulations and Nav Canada air navigation technologies and practices. Nav Canada, the air navigation service provider, is currently beginning a comprehensive three-year study to examine the present air navigation system in the Toronto area to ensure that their services are meeting the needs of users in the most efficient manner. Should the results of Nav Canada's review lead to the future application of new technologies, procedures or practices that increase the hourly airside throughput potential, the annual airside capacities calculated in this chapter may need to be reassessed. However, the capacities presented in this chapter have been reviewed by Nav Canada and accurately reflect the Airport's present and future capacity based on information known at the present time.

5.5.7 Conclusion

A number of possible means of increasing the ultimate airside capacity of Toronto Pearson have been identified and discussed in this section, some of which appear to have a theoretical potential to increase airside passenger capacity, perhaps in the 5-10 per cent range or more if considered in combination.

The key issue is the extent to which the measures would be practical to implement at Toronto Pearson in the future. While some of the ideas could be effective to deal with a short-term capacity shortfall, it is not clear whether they would be appropriate to implement on a sustained basis. Another fundamental consideration is that the GTAA does not have unilateral control over the measures, and in many cases, has only a limited ability to influence the outcome. The successful implementation of any of the measures would depend on the actions and responses of a number of other important players in the aviation industry including the passengers, the airlines, the business aviation community, Nav Canada, Transport Canada and the surrounding communities.

While some of the measures identified are likely to warrant further consideration in the future when congestion begins to develop at the Airport, there is not sufficient evidence at this time to suggest that it will be both possible and practical to implement any of the measures on a sustained basis to significantly increase Toronto Pearson's practical capacity.

5.6 SUMMARY

Based on the analysis presented in this chapter, the current five-runway airside system at Toronto Pearson can accommodate Transport Canada's forecast aircraft movement demand into the 2013-2019 time period. The exact time that additional airside infrastructure is required will depend on not only future traffic growth rates, but also on the willingness of the aviation community to accept airside congestion and delays as demand surpasses the practical capacity of the existing airside system and progresses toward its maximum capacity.

Plans for the provision of a sixth and final runway and supporting taxiway and navigational aid infrastructure have been developed, including the completion of an environmental assessment. The addition of the sixth runway would provide an approximate 10-15 per cent increase in capacity, raising the Airport's ultimate airside capacity to the 580,000 to 680,000 annual aircraft movements range, which equates to approximately 46-54 million passengers annually.

A number of other potential airside improvements that would enhance the efficiency of airport operations have also been identified and described in this chapter, however, they are relatively modest in nature in comparison to the addition of the sixth runway. Ongoing monitoring of airside operations will be required to determine more precise requirements for and timing of these or other airside infrastructure improvements with sufficient lead time to design, construct and commission the facilities.

Based on Transport Canada's aircraft movement forecasts, the full six-runway airside system would be able to accommodate the demand at the Airport until approximately the 2017-2023 time period. Beyond that time, other solutions to accommodate growth in the regional aircraft traffic demand would be required, as will be discussed in Chapter 15.