NOISE EXPOSURE FORECAST STUDY – WINNIPEG INTERNATIONAL AIRPORT

FINAL REPORT | AUGUST 12, 2021

HM AERO
AVIATION CONSULTING

Landmark
Planning & Design Inc.

NOISE EXPOSURE FORECAST STUDY – WINNIPEG INTERNATIONAL AIRPORT

Final Report

Province of Manitoba
Manitoba Municipal Relations

August 12, 2021

HM Aero Inc.
532 Montreal Road, Suite 209
Ottawa, ON K1K 4R4

Landmark Planning and Design Inc.
289 Waterfront Drive
Winnipeg, MB R3B 0G5

Cover Image: Google Earth

Revision History

Rev.	Date	Status	Notes
0	December 11, 2020	Draft	Issued for internal review to the Province of Manitoba.
1	January 8, 2021	Final	Issued for use by the Province of Manitoba. Revisions made based on internal comments.
2	August 12, 2021	Final	Issued for use by the Province of Manitoba. Revisions made based on input received during the 45-day consultation period of the Proposed Airport Vicinity Protection Area Regulation. Changes are as follows: • Increased the grid spacing resolution from 1,000 ft. x 1,000 ft. to 100 ft. x 100 ft. for all NEF contours; • Corrected a technical error in direction (left-hand vs. right-hand) and height of local circuit procedures; and • Corrected a technical error in the calculation of the Scenario 4 – Ultimate-Term Conceptual Conditions Peak Planning Day, from 1,082 movements to 1,245 movements.

Table of Contents

List of Figures

List of Tables

List of Acronyms

Acronym	Definition
AVPA	Airport Vicinity Protection Area
GDP	Gross Domestic Product
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
NCAMS	NAV CANADA Aircraft Movement Statistics
NEF	Noise Exposure Forecast
NEP	Noise Exposure Projection
NM	Nautical Miles
PACM	Prototype Airfield Capacity Model
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
WAA	Winnipeg Airports Authority

1 INTRODUCTION

1.1 Background

The aviation sector has experienced considerable growth in the 21st century as passenger and cargo air carriers, charter operators, air ambulance service providers, and other entities have increased their operations to meet the demand for domestic, transborder, and international travel. As a result, numerous Canadian airports have experienced similar growth as activity levels increase and new infrastructure is developed.

Simultaneously, residential, commercial, and industrial development in large municipalities such as Winnipeg has resulted in the outward expansion of urban areas. Increasingly, this has resulted in airports being positioned in closer proximity to noise sensitive areas that were previously distanced. This poses a range of compatibility concerns, including aircraft noise – increased aircraft movements can disrupt sensitive land uses such as residential neighbourhoods, schools, and retirement communities, among others. While noise concerns can be mitigated for existing communities through measures such as modified flight paths and procedures, appropriate planning that separates sensitive land uses from areas of high noise exposure can proactively minimize future conflicts.

Winnipeg James Armstrong Richardson International Airport (Winnipeg International Airport) is a critical air travel hub, serves as a major linkage in the domestic and international supply chain and logistics network, and generates an estimated $2.9 billion in direct economic output annually[1]. The scale of Winnipeg's operations has the potential to increase in the future; however, this growth could result in increased land use conflicts.

1.2 Study Objectives

In September 2020, the Province of Manitoba retained HM Aero Inc. (HM Aero) and its subconsultant, Landmark Planning & Design Inc. (Landmark Planning), to provide a Noise Exposure Forecast Study for Winnipeg International Airport and a subsequent Comprehensive Planning Analysis and Recommendations Report. The purpose of the Noise Exposure Forecast Study is to update the noise contours that may inform the City of Winnipeg's Airport Vicinity Protection Area Secondary Plan with independently prepared contours that consider multiple scenarios.

The Noise Exposure Forecast Study has three primary components:

1. **Aircraft Movement Forecasts:** Forecasting the potential future activity at Winnipeg International Airport is critical to modelling how aircraft noise may impact surrounding land uses. Aircraft movement forecasts have been prepared on an annual basis to 2050 to identify the traffic levels that will be modelled in the 2033 and 2050 noise contours.
2. **Runway Capacity Analysis:** The annual aircraft movement capacity of Winnipeg International Airport's two runways is calculated to assist the Province in considering whether a new runway may be required to provide additional capacity within the 30-year horizon (2050) of the study. Further, capacity is estimated in an 'ultimate-term' scenario that considers the addition of a new runway and will inform the development of noise contours that represent the maximum potential utilization of Winnipeg International Airport.

[1] InterVISTAS Consulting Inc. (n.d.). *2020 Economic Impact Study Final Report: Winnipeg James Armstrong Richardson International Airport (YWG).*

3. **Noise Contour Scenarios:** The study presents four noise contour scenarios:

   Scenario 1 – 2019 Baseline Conditions: Contours derived from 2019 aircraft movement statistics to illustrate the baseline conditions of Winnipeg International Airport. 2019 has been selected as the baseline as, at the time of this report's preparation in the fall of 2020, full-year aircraft movement data for 2020 was not available. Further, the COVID-19 pandemic has had a significant negative impact on aircraft movements at Winnipeg International Airport in 2020 that is inconsistent with trends exhibited in previous years.

   Scenario 2 – 2033 Forecast Conditions: Contours that illustrate conditions at the end of the planning horizon of the Winnipeg Airports Authority's (WAA's) 2033 Master Plan for Winnipeg International Airport.

   Scenario 3 – 2050 Forecast Conditions: Illustrates forecast noise conditions over a 30-year planning horizon, which aligns with the horizons of municipal and regional plans such as the OurWinnipeg 2045 Draft Plans and the Capital Planning Region 2050 Draft Plan.

   Scenario 4 – Ultimate-Term Conceptual Conditions: Considers the noise conditions at an indeterminate time in the future where a third runway is implemented, and the three-runway system operates at its maximum capacity.

The Noise Exposure Forecast Study has been prepared for the exclusive use of the Province of Manitoba. Any use, reliance on, or decision made by a third party based on this report is the sole responsibility of that third party.

1.3 Noise Measurement and Contours

1.3.1 Noise Measurement

As described by Transport Canada in TP1247 – Land Use in the Vicinity of Aerodromes (9th Ed.), the sound pressure of a given source, such as an overflying aircraft, can be measured in the unit of the decibel (dB). The Effective Perceived Noise Level has been developed to better approximate the reaction of humans to aircraft noise, measured in the unit of EPNdB. The determination of the Effective Perceived Noise Level is part of the certification process for aircraft and includes corrections to address matters that contribute to the annoyance of humans such as the duration of the noise event (i.e., the aircraft overflight).

1.3.2 Noise Exposure Forecast System

Annoyance from aircraft noise includes factors beyond the one-time impacts of an overflying aircraft. For example, the number of flights that occur per day, the concentration and distribution of flights, the time of day that overflights occur, and the Effective Perceived Noise Levels of aircraft in use all contribute to annoyance. In Canada, the Noise Exposure Forecast System has been used since 1971 to predict the overall subjective annoyance and reaction levels caused by aircraft operations on specific land uses.

The Noise Exposure Forecast System generates noise contours, which are lines of constant levels of perceived annoyance caused by airport noise sources. Research and analysis by the National Research Council has resulted in a numeric rating for predicted annoyance levels and the recommended types of development that should be allowed within the affected areas.

Under the umbrella of the Noise Exposure Forecast System, Transport Canada describes three types of contours that are differentiated according to the planning horizon of the supporting data inputs:

1. **Noise Exposure Forecast (NEF) Contours:** Aircraft types and mix as well as traffic volume used in calculating the NEF contours are normally forecast for a period of between 5 to 10 years into the future. The existing runway geometry is used, as well as any planned changes to the airfield within the 5-to-10-year horizon.
2. **Noise Exposure Projection (NEP) Contours:** Based on a projection of aircraft movements more than 10 years into the future and includes aircraft types and runway configurations that may materialize within this period.
3. **Noise Planning Contours:** Produced to investigate planning alternatives, such as the impacts of a new runway, hypothetical airport traffic scenarios, changing aircraft fleet types, etc.

Despite their unique naming, NEF, NEP, and Noise Planning Contours are generated using the same software and methodology.

As described in Section 1.2, fours sets of noise contours have been prepared for Winnipeg International Airport to depict baseline conditions in 2019, forecast conditions in 2033 and 2050, and conditions in a conceptual 'ultimate-term'. Table 1.1 identifies how the four scenarios are defined according to the three types of noise contours described by Transport Canada. While the 2019 baseline scenario does not fit any of the three definitions as it is a historical occurrence and not a future case, the software and methodology used in the preparation of all four noise contour sets is consistent and appropriate.

Table 1.1 - Study Scenario NEF Definitions

Study Scenario	NEF Contours	NEP Contours	Noise Planning Contours
	5 - 10 Years	> 10 Years	Scenario Based
Scenario 1 – 2019 Baseline Conditions	No	No	No
Scenario 2 – 2033 Forecast Conditions	No	Yes	No
Scenario 3 – 2050 Forecast Conditions	No	Yes	No
Scenario 4 – Ultimate-Term Conceptual Conditions	No	No	Yes

1.3.3 Community Response to Noise

TP1247 – Land Use in the Vicinity of Aerodromes (9th Ed.) forms the basis for Transport Canada's recommendations on development controls near airports as a function of aircraft noise and perceived annoyance. These guidelines are widely used by Canadian municipalities to ensure that the development of noise sensitive facilities and residential areas is appropriately controlled. Included in TP1247 and shown in Table 1.2 are predictions of community response to commonly modelled NEF contours.

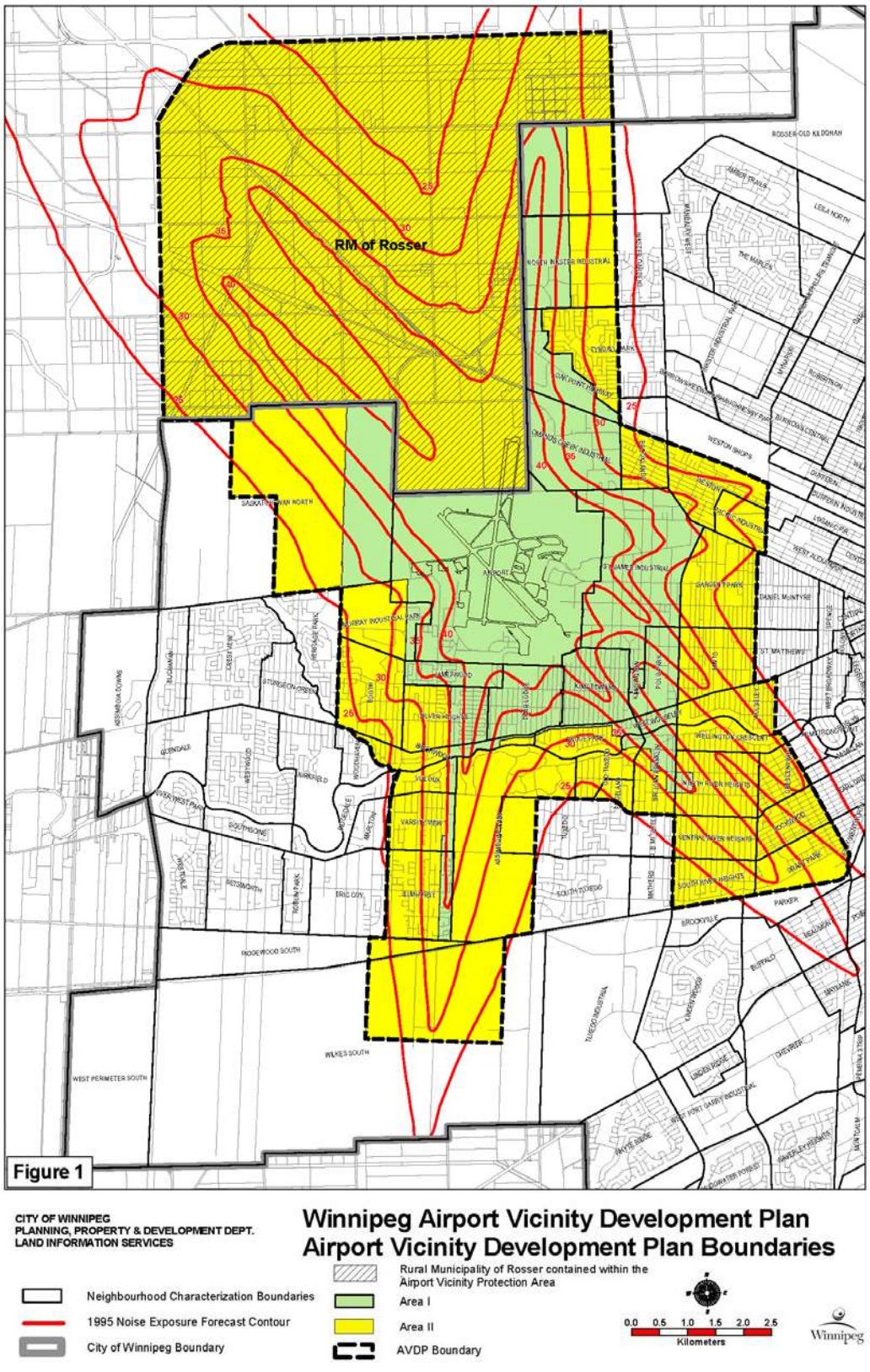
Table 1.2 - Community NEF Response Prediction (Transport Canada)

Response Area	Response Prediction*
1 (over 40 NEF)	Repeated and vigorous individual complaints are likely. Concerted group and legal action might be expected.
2 (35-40 NEF)	Individual complaints may be vigorous. Possible group action and appeals to authorities.
3 (30-35 NEF)	Sporadic to repeated individual complaints. Group action is possible.
4 (below 30 NEF)	Sporadic complaints may occur. Noise may interfere occasionally with certain activities of the resident.
* The above community response predictions are generalizations based upon experience resulting from the evolutionary development of various noise exposure units used by other countries. For specific locations, the above response areas may vary somewhat in accordance with existing ambient or background noise levels and prevailing social, economic, and political conditions.	

1.4 Winnipeg Airport Vicinity Protection Area Secondary Plan

As stated in the 1994 Airport Vicinity Protection Area (AVPA) Secondary Plan, the boundaries of the protection area are tied to NEF contours. The AVPA Area II outer limit approximates the 25 NEF contour, and the characteristics of the NEF contours reflect the potential for an additional parallel runway. While the contours presented in the AVPA and associated Areas I and II are intended to represent an ultimate scenario, the assumptions and inputs used in their generation are not documented in the AVPA. The contours presented in the AVPA are illustrated in Figure 1.1.

Figure 1.1 – AVPA Areas and 1995 NEF Contours



2 AIRCRAFT MOVEMENT FORECASTS

2.1 Historical Activity Review

An aircraft movement is defined as a take-off, landing, touch-and-go, or simulated approach. Full-year aircraft movement data for Winnipeg International Airport was available from Statistics Canada for the period of 1997 to 2019. By examining historical data, trends over time can be identified to inform forecasts of future activity at Winnipeg International Airport.

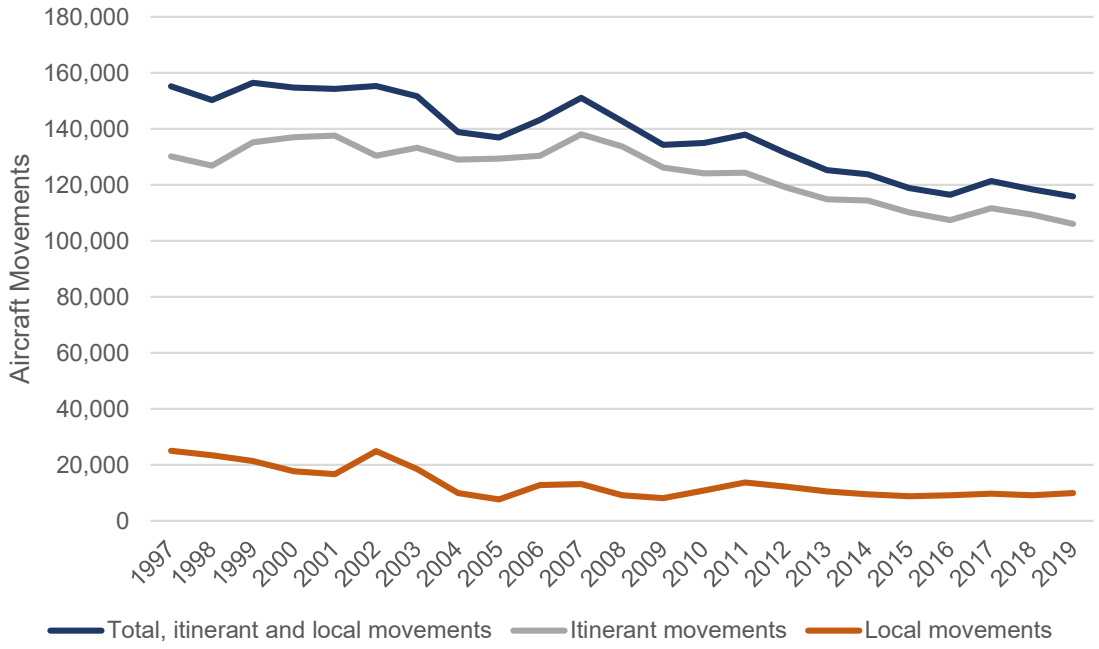
2.1.1 Total, Itinerant, and Local Aircraft Movements

Activity at Winnipeg International Airport has decreased from approximately 155,200 aircraft movements in 1997 to 115,900 movements in 2019, as shown in Figure 2.1[2]. This represents a total decrease of 25.3% from 1997 to 2019, or an average annual decrease of 1.2%. Over the past ten years, activity has decreased by an average of 1.6% per year from 135,000 aircraft movements in 2010 to 115,900 movements in 2019.

Aircraft movements can be further classified as itinerant or local. Itinerant movements at controlled airports are defined by Statistics Canada as flights where:

- An aircraft proceeds to, or arrives from, another location; or
- An aircraft leaves the airport traffic pattern and returns without landing at another airport.

Figure 2.1 - Total, Itinerant, and Local Aircraft Movements



[2] Except where otherwise shown in the report, aircraft movements are rounded to the nearest hundred.

Itinerant aircraft movements have decreased by 18.5% from 130,200 in 1997 to 106,100 in 2019, or 0.8% per year. From 2010 to 2019, itinerant movements decreased from 124,100 in 2010 to 106,100 in 2019 – a decrease of 1.6% per year.

For airports with control towers, local aircraft movements are defined by Statistics Canada as flights that remain in the airport traffic pattern. This category commonly includes flight training and maintenance / test flights. Local aircraft movements have decreased from 25,000 in 1997 to 9,800 in 2019. This represents a decrease of 2.8% per year. This decrease has slowed in the last ten years, with local movements having declined by 1.0% annually from 10,800 in 2010 to 9,800 in 2019.

2.1.2 Aircraft Operators

Statistics Canada classifies itinerant aircraft movements into six operator categories:

1. Air Carrier, Level I-III and Foreign;
2. Air Carrier, Level IV-VI;
3. Other Commercial;
4. Private;
5. Government – Civil; and
6. Government – Military.

Air Carrier Movements

Air carrier movements include flights transporting people, mail, and / or goods that are performed by commercial operators licensed by the Canadian Transportation Agency. For discussion purposes, the two air carrier classifications (Level I-III and Foreign, Level IV-VI) are consolidated into one. Examples of air carriers that operate at Winnipeg International Airport include Air Canada, WestJet, CargoJet, Perimeter Aviation, Keewatin Air, and Calm Air.

Air carriers have been responsible for the majority of the itinerant aircraft movements at Winnipeg International Airport from 1997 to 2019, ranging from 78% to 90% of movements in this category on an annual basis. As shown in Figure 2.2, itinerant air carrier operations increased from 103,800 movements in 1997 to a maximum of 120,900 movements in 2007, before decreasing to between 95,400 and 100,000 annual movements in 2015-2019. From 1997 to 2019, itinerant air carrier movements have decreased by an annual average of 0.4%. Between 2007 and 2019, the annual average decrease was 1.7%.

Despite the historical decrease in air carrier movements, passenger and air cargo activity has generally increased at Winnipeg International Airport as shown in Figure 2.3. This trend is a result of factors such as:

- Improved aircraft utilization with route maturation and optimized airline revenue management – for example, a CRJ-200 that operated at an 80% load factor (40 passengers) now operating at a 90% load factor (45 passengers); and
- The deployment of aircraft with higher capacities – for example, the use of a 142 seat Airbus A320 on a route that was formerly operated by a 76 seat CRJ-900.

As will be considered in the forecasting discussion below, future growth in air cargo and passenger activity is not expected to correspond uniformly with increases in aircraft movements.

Figure 2.2 - Itinerant Air Carrier Movements

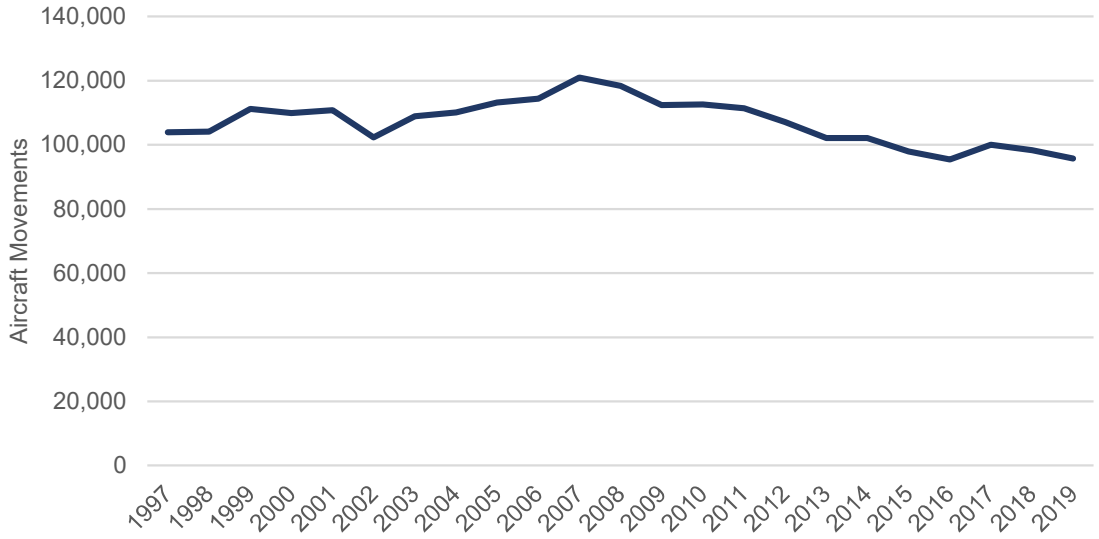
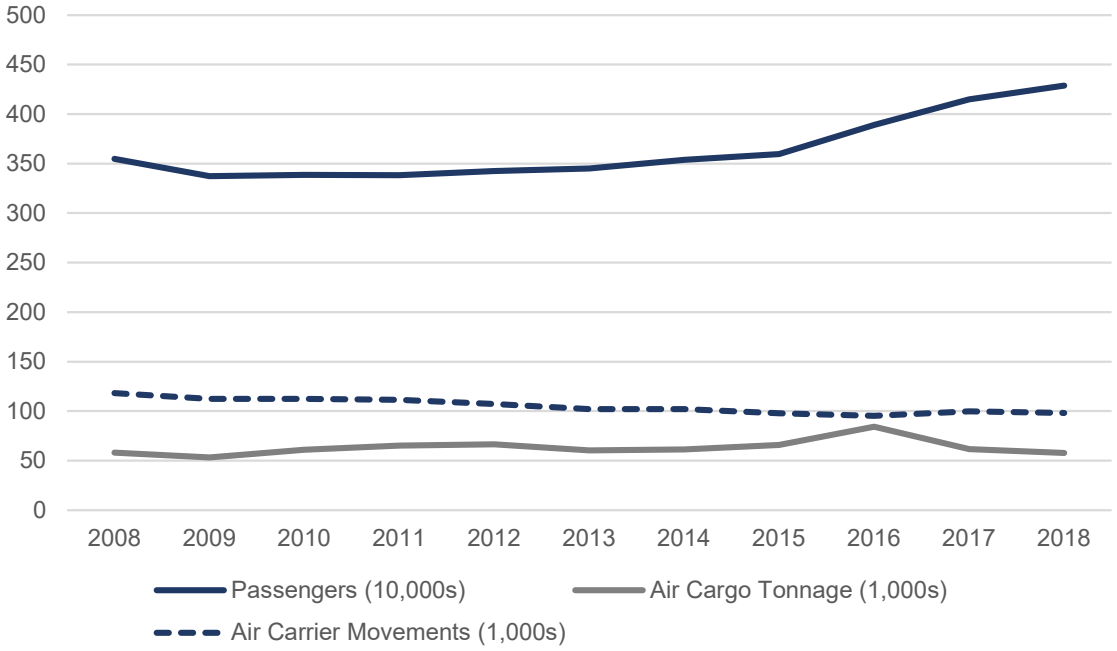


Figure 2.3 - Itinerant Air Carrier, Passenger, and Cargo Activity

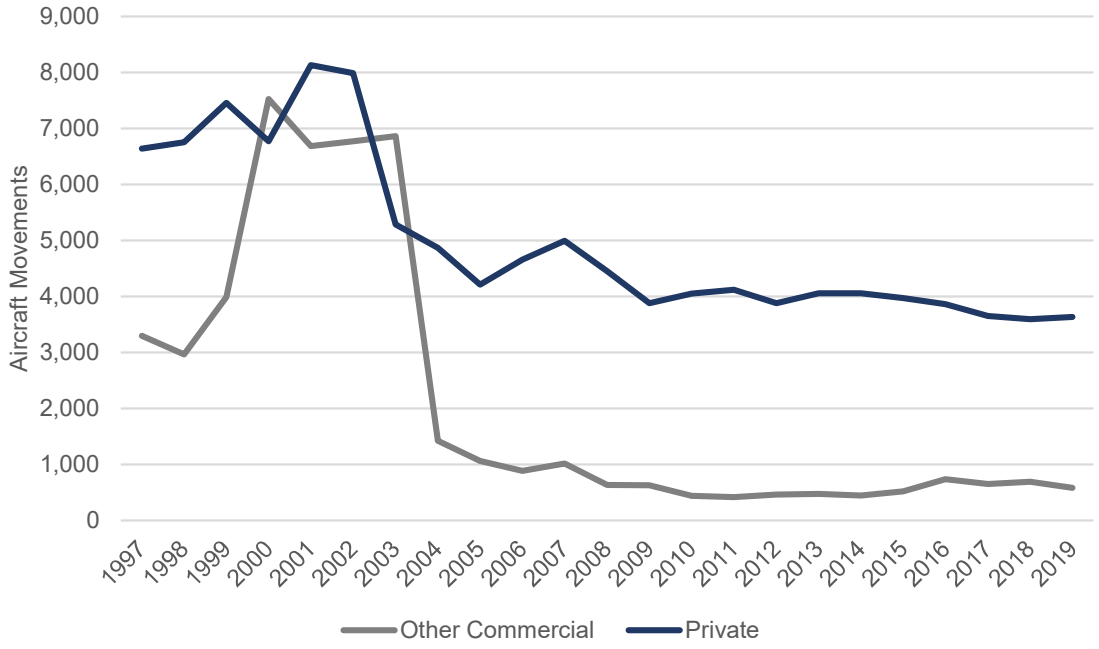


Other Commercial Movements

The Statistics Canada other commercial category includes flights performed by Canadian Transportation Agency licensed aircraft operators that are not encompassed within passenger and cargo air carrier operations. This includes operators such as flight training units, agricultural applicators, and aerial surveyors.

As shown in Figure 2.4, other commercial itinerant movements increased from 3,300 in 1997 to a maximum of approximately 7,500 in 2000. Movements decreased in subsequent years to 1,400 in 2004 and 600 in 2019. From 2010 to 2019, an average of 500 annual other commercial itinerant movements were recorded at Winnipeg International Airport.

Figure 2.4 - Itinerant Other Commercial and Private Movements



Private Movements

Private movements are aircraft not used for hire or compensation that are owned by individuals, groups, and businesses. Itinerant private movements have decreased from a maximum of 8,100 in 2001 to 3,600 in 2019, or an average annual decrease of 3.1% (Figure 2.4). From 2010 to 2019, itinerant private movements have decreased by an average of 1.1% annually, with an average of 3,900 annual movements in this period.

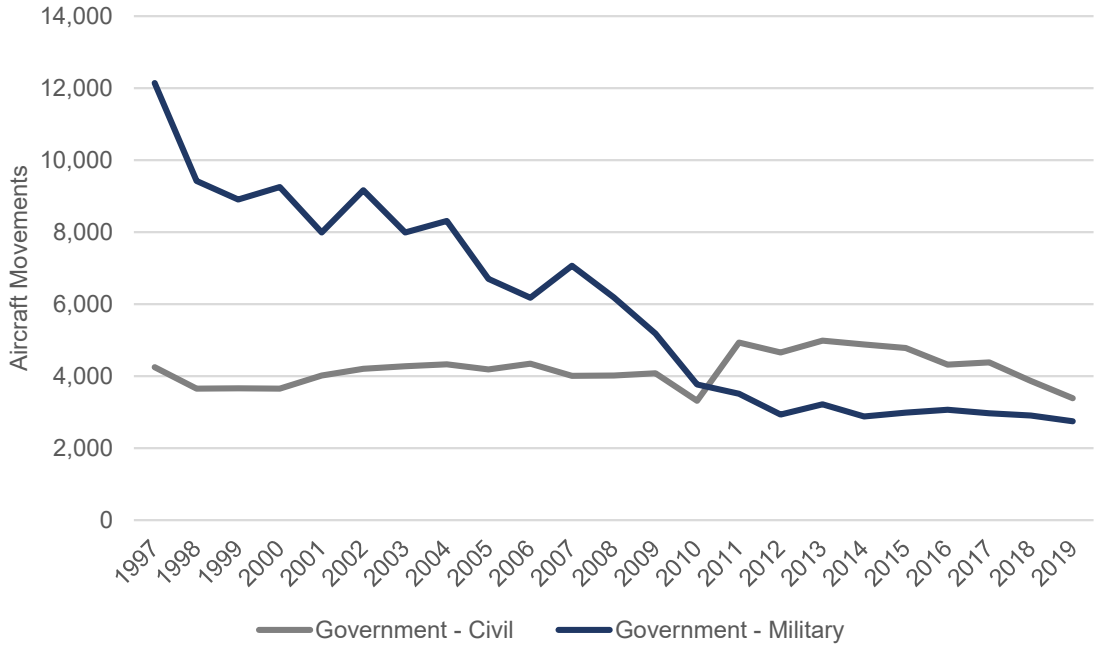
Government – Civil Movements

Itinerant movements in this category include aircraft owned by foreign, federal, provincial, and municipal governments. The Province of Manitoba has historically maintained a significant aviation services presence at Winnipeg International Airport for wildfire suppression, air ambulance and medevac operations, and justice transportation flights. Government – civil itinerant movements have exhibited variability between 1997 and 2019, ranging from lows of 3,300 and 3,400 movements in 2010 and 2019, respectively, to highs of 4,900 and 5,000 movements in 2011 and 2013, respectively (Figure 2.5).

Government – Military Movements

This category includes aircraft of any branch of the armed forces of any nation, including the Royal Canadian Air Force. 17 Wing Winnipeg, which is collocated with Winnipeg International Airport, supports several Royal Canadian Air Force squadrons that are engaged in training, search and rescue, and other roles. As shown in Figure 2.5, government – military itinerant aircraft movements have exhibited a downward trend over time, decreasing from 12,100 movements in 1997 to 2,700 movements in 2019.

Figure 2.5 - Itinerant Government Civil and Military Movements



2.1.3 Aircraft Sizes

Data on aircraft sizes and types can be inferred through Statistics Canada's dataset on aircraft Maximum Take-Off Weights. Statistics Canada classifies each itinerant aircraft movement into one of ten Maximum Take-Off Weight categories, which have been simplified to five categories for this analysis as summarized below and shown in Figure 2.6 and Table 2.1:

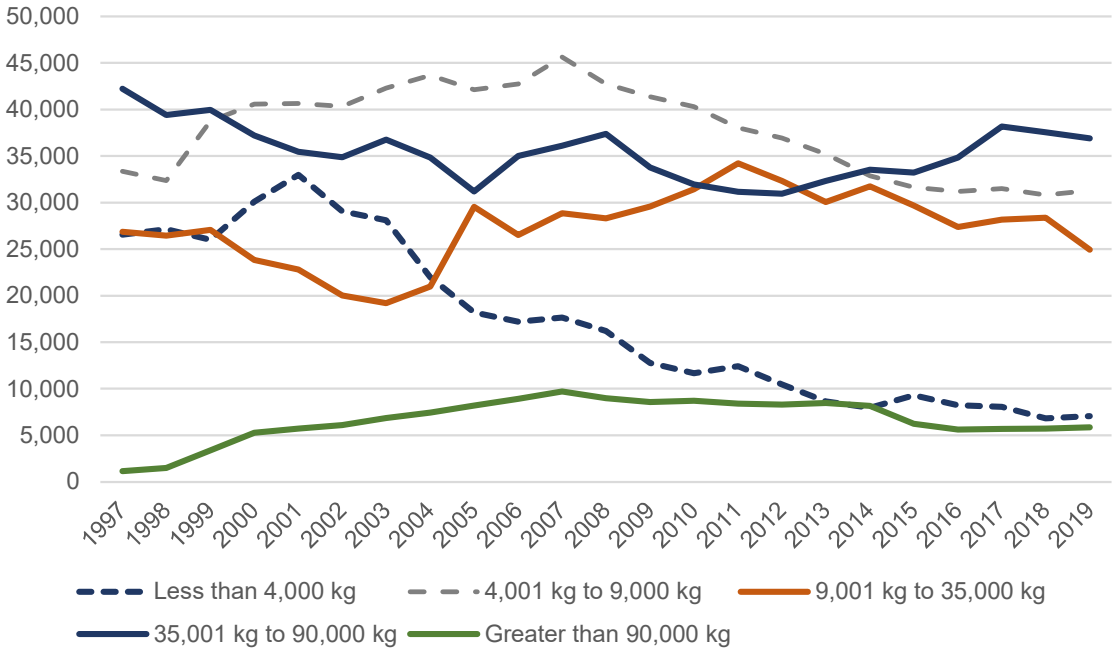
- **Less than 4,000 kg:** Both the total number and proportion of itinerant movements operated by small aircraft such as the Cessna 172 and Beechcraft Baron has decreased from 1997 to 2019. Such aircraft were responsible for 20% of itinerant movements in 1997, 9% in 2010, and 7% in 2019.
- **4,001 kg to 9,000 kg:** Aircraft such as the Beechcraft King Air, Cessna Citation, and Beechcraft 1900 have remained relatively steady in their proportion of itinerant movements, ranging between 25% and 34% across the dataset. The total number of itinerant movements in this category has ranged between approximately 30,000 and 45,000 annual movements throughout the data period, with a consistent decrease experienced from 2008 to 2019.

- **9,001 kg to 35,000 kg:** The proportion of itinerant movements performed by regional aircraft has increased from 21% in 1997 to 24% in 2019, with an average of 26% between 2010 and 2019. Examples of aircraft in this category include the Saab 340, ATR 42 and 72, Bombardier CRJ-200, and De Havilland Canada Dash 8-100/300/400. The number of annual movements in this category has ranged between 19,200 (2003) and 34,200 (2011), reaching 24,900 movements in 2019.
- **35,001 kg to 90,000 kg:** Over the past ten years, the proportion of itinerant aircraft movements in this category has increased from 26% in 2010 to 35% in 2019. Aircraft in this category include larger regional jets and mid-range airliners such as the Bombardier CRJ-900; Embraer 175 and 190; Boeing 737; and Airbus A220, A319, A320, and A321. While the proportional share of movements in this category has increased, the number of annual movements has decreased from 42,200 in 1997 to 32,000 in 2010 and 37,000 in 2019.
- **Greater than 90,000 kg:** Movements at the largest end of the scale have increased from 1% of itinerant traffic in 1997 to an average of 6% between 2010 and 2019. This includes long-range and wide-body aircraft used by passenger and cargo air carriers such as the Boeing 747, 757, and 767 and Airbus A300, A310, and A330. The number of annual movements in this category increased from approximately 1,200 in 1997 to a maximum of 9,700 in 2007, before decreasing to 5,900 in 2019.

Table 2.1 - Itinerant Movements by Maximum Take-Off Weight

Maximum Take-off Weight	1997		2010		2019	
	Proportion	Movements	Proportion	Movements	Proportion	Movements
Less than 4,000 kg	20%	26,561	9%	11,678	7%	7,050
4,001 kg to 9,000 kg	26%	33,360	32%	40,305	30%	31,311
9,001 kg to 35,000 kg	21%	26,860	25%	31,424	24%	24,934
35,001 kg to 90,000 kg	32%	42,241	26%	31,971	35%	36,916
Greater than 90,000 kg	1%	1,150	7%	8,736	6%	5,877
Total	100%	130,172	100%	124,114	100%	106,088

Figure 2.6 - Itinerant Movements by Maximum Take-Off Weight



Considering these inputs together, an increasing proportion of itinerant movements at Winnipeg International Airport are performed by larger aircraft with higher Maximum Take-Off Weights, driven primarily by the decreased use of the facility by smaller aircraft. However, as noted in Section 2.1.1, this trend is caveated by the fact that the total number of itinerant movements has gradually decreased at Winnipeg International Airport.

2.2 Aircraft Movement Forecast

2.2.1 Preface

Aircraft movements are forecast to approximate the level of traffic that could occur at Winnipeg International Airport in the future, which informs the noise contours described in this report. Aircraft movement forecasts, while technical in nature and prepared using the best available data sources, are fraught with uncertainty as future conditions emerge that cannot reasonably be predicted or modelled. Generally, forecast accuracy decreases over time as the number of uncertainties and events that influence the underlying assumptions increases. For example, events that could impact the accuracy of the forecasts presented herein include:

- The impacts of the ongoing COVID-19 pandemic;
- New air carrier routes and service terminations;
- Inter-airport competition;
- Changes to airport rates and fees and the price elasticity of aircraft operators; and
- The economic prospects of Winnipeg and Manitoba.

The aircraft movement forecasts prepared as part of the WAA's 2033 Master Plan illustrate the challenges and uncertainties that must be contended with in the planning process. As shown in Table 2.2, the number of movements forecast in the 2013 and 2018 "Most Likely" scenarios exceeded actual activity by approximately 1,400 and 19,000 aircraft movements, respectively.

Table 2.2 - 2033 Master Plan Aircraft Movement Forecast (WAA)

	2012	2013	2018
Actual	131,243	125,266	118,352
Low Scenario		125,000 (-266)	124,700 (+6,348)
Most Likely Scenario		126,700 (+1,434)	137,400 (+19,048)
High Scenario		128,400 (+3,134)	145,800 (+27,448)

Accordingly, the following considerations underly the forecasts presented in this report:

- The forecasts are based on the independent analysis of HM Aero and do not represent the positions of the Province of Manitoba or the WAA;
- Forecast data should be interpreted as an illustration of what future activity at Winnipeg International Airport could look like given the realization of an underlying set of assumptions;
- While every effort has been made to maximize the accuracy of the forecasts contained herein, variability in year-over-year activity should be expected; and
- The forecasts provided herein are strictly for the purposes of the Noise Exposure Forecast Study.

2.2.2 Process

The aircraft movement forecasts provided herein were prepared following a five-step process which was supported by an aviation industry economist as part of the project team:

1. Historical aircraft movement data from Statistics Canada was reviewed from 1997 to 2019 to identify trends over time.
2. Industry literature and resources were reviewed to identify potential developments that could impact activity levels at Winnipeg International Airport. Sources included:
   - Data from the International Air Transport Association, Boeing, and National Airlines Council of Canada on the anticipated recovery of the passenger air travel sector from the COVID-19 pandemic;
   - Economic and financial institutions such as the International Monetary Fund, Organisation for Economic Co-operation and Development, Bank of Montreal, and Royal Bank to identify forecasted changes in Gross Domestic Product;
   - Publications from the Government of Canada and WAA on future investments and growth in air cargo activity at Winnipeg International Airport; and
   - Air cargo market forecasts published by Airbus and Boeing.
3. Eight aircraft movement sub-groups were created to aid in the preparation of forecast assumptions based on the data reporting classifications provided by Statistics Canada previously described in Section 2.1[3]:

[3] The Statistics Canada Itinerant Air Carrier (Level I-III and Foreign) Movements dataset does not differentiate between passenger and cargo movements. The project team has created passenger and cargo sub-classifications to more accurately forecast the differing trends of each sector.

i. Itinerant Passenger Air Carrier Movements (Level I-III and Foreign);
ii. Itinerant Cargo Air Carrier Movements (Level I-III and Foreign);
iii. Itinerant Air Carrier Movements (Level IV-VI);
iv. Itinerant Other Commercial Movements;
v. Itinerant Private Movements;
vi. Itinerant Government Civil Movements;
vii. Itinerant Government Military Movements; and
viii. Local Movements.

4. Assumptions were developed based on the trends exhibited in each sub-group to forecast future activity levels using the following techniques – the application of each technique across the eight aircraft movement sub-groups is shown in Table 2.3:

   - **Linear on Gross Domestic Product (GDP):** Increasing activity as a linear function of GDP. If GDP grows by a certain amount, activity is forecast to increase by a multiple of this amount.
   - **Log-Linear on GDP**: The common logarithm of activity is a function of the common logarithm of GDP. If GDP grows by a certain percentage, then activity is forecast to grow by a percentage that is a multiple of the percentage GDP growth.
   - **Constant Organic Change:** Activity is estimated to change by a fixed percentage each year. This percentage is based on historical data and linear regression, information from the above-noted industry resources and publications, and / or the professional opinion of the project team.
   - **Secondary Sources:** Growth rates from other sources that produce long-term aviation forecasts are inputted to the Winnipeg context.

5. Forecast data was reviewed internally by the project team through a Quality Control process.

Table 2.3 - Forecasting Techniques

	Linear on GDP	Log-Linear on GDP	Constant Organic Change	Secondary Sources
Itinerant Passenger Air Carrier Movements (Level I-III and Foreign)	Yes	Yes	No	Yes
Itinerant Cargo Air Carrier Movements (Level I-III and Foreign)	No	No	Yes	No
Itinerant Air Carrier Movements (Level IV-VI)	No	No	Yes	No
Itinerant Other Commercial Movements	No	No	Yes	No
Itinerant Private Movements	No	No	Yes	No
Itinerant Government Civil Movements	No	No	Yes	No
Itinerant Government Military Movements	No	No	Yes	No
Local Movements	No	No	Yes	No

2.2.3 Assumptions

Itinerant Passenger Air Carrier Movements (Level I-III and Foreign)

Passenger air carrier movements by major airlines (Level I-III and Foreign) such as Air Canada and WestJet are a significant source of traffic at Winnipeg International Airport. Activity in this category is forecast in two segments:

1. 2020-2025, accounting for reduced activity as a result of COVID-19; and
2. 2026-2050, using GDP-based long-term growth models.

2020-2025

The COVID-19 pandemic is having widespread negative impacts on air carriers and airports across Canada, including Winnipeg International Airport. Based on the most recently available data at the time of this report's preparation, aircraft movements at Winnipeg International Airport have decreased by 43% from April to September 2020 compared to the same period in 2019. As a result of decreased passenger demand, air carriers have reduced service across the country. This has included the termination of routes between cities, deploying smaller aircraft on retained routes, reducing the frequency of retained services, and retiring and storing surplus aircraft.

The way demand will recover and service will be restored at Winnipeg International Airport remains a matter of considerable uncertainty. It is anticipated that airlines will be conservative in restoring capacity to maintain their financial strength after several years of challenging market conditions. Based on recent materials prepared by organizations such as the International Air Transport Association and the independent opinion of the project team, the recovery of passenger air carrier operations to 2019 levels at Winnipeg International Airport is assumed to occur in 2025.

The exact path that forecast activity will follow between 2020 and 2025 is a matter of considerable discussion within the aviation industry and is subject to significant uncertainty, including factors such as:

- Interprovincial, intra-provincial, and international travel restrictions and guidelines imposed by public health agencies;
- Consumer confidence regarding the perceived risk of disease transmission on air travel; and
- Changing business travel practices, such as the increased usage of digital meetings.

2026-2050

Following 2025, Linear and Log-Linear GDP models are used to forecast passenger air carrier activity. WAA publishes domestic, transborder, and international passenger data from 2005 to 2019 which is supplemented by Statistics Canada data from 1996 to 2007. The Statistics Canada dataset was scaled to be consistent with the WAA dataset and address minor errors.

As shown in Table 2.4, regression analyses were performed for each passenger activity segment (domestic, transborder, and international) against historical GDP. The results are uniformly significant, as attested by the strong F-statistics that exceed 19.4 (significance level of over 95%). The GDP and time coefficients in both the Linear and Log-Linear analyses are positive and highly significant. Accordingly, the Linear GDP methodology is selected as the basis for forecasting future passenger air carrier movements.

Ten GDP forecasts are presented in Table 2.5 that form the basis of the Linear GDP passenger forecast. Given economic uncertainty over time, these sources generally do not publish forecasts beyond the five-year horizon. The forecasts to 2050 must therefore use shorter term growth rates.

Table 2.4 - Historical Passenger Activity vs. GDP Regression Analysis

	Domestic Passengers	Transborder Passengers	International Passengers
Linear GDP			
R-Squared	0.741114	0.57583	0.9014719
F Statistic	62.979487	29.8661	201.28659
Log-Linear GDP			
R-Squared	0.6891213	0.56272	0.900602
F Statistic	48.767153	28.3112	199.33243

Table 2.5 - Gross Domestic Product Forecasts

Source *	Date	2020	2021	2022	2023	2024	2025	2026
Royal Bank	Sep. 10, 2020	-6.0%	4.9%					
Bank of Montreal	Aug. 28, 2020	-5.5%	6.0%					
National Bank	Oct. 2020	-5.7%	4.1%	4.8%				
Toronto Dominion Bank	Sep. 18, 2020	-5.6%	4.1%	3.2%	1.8%	1.7%	1.7%	1.6%
CIBC	Oct. 21, 2020	-5.5%	4.1%					
Conference Board **	Jun. 2020		6.7%	4.8%				
International Monetary Fund	Oct. 2020	-7.1%	5.2%					
Bank of Nova Scotia	Oct. 14, 2020	-5.7%	4.1%	3.1%				
Bank of Canada	Oct. 2020	-5.5%	4.0%	4.0%				
OECD	Jun. 2020	-9.4%	1.5%					
Forecast Assumption			4.0%	3.0%	1.8%	1.7%	1.7%	1.7%

* Forecasts retrieved from the National Bank Monthly Economic Monitor, Oct. 2020

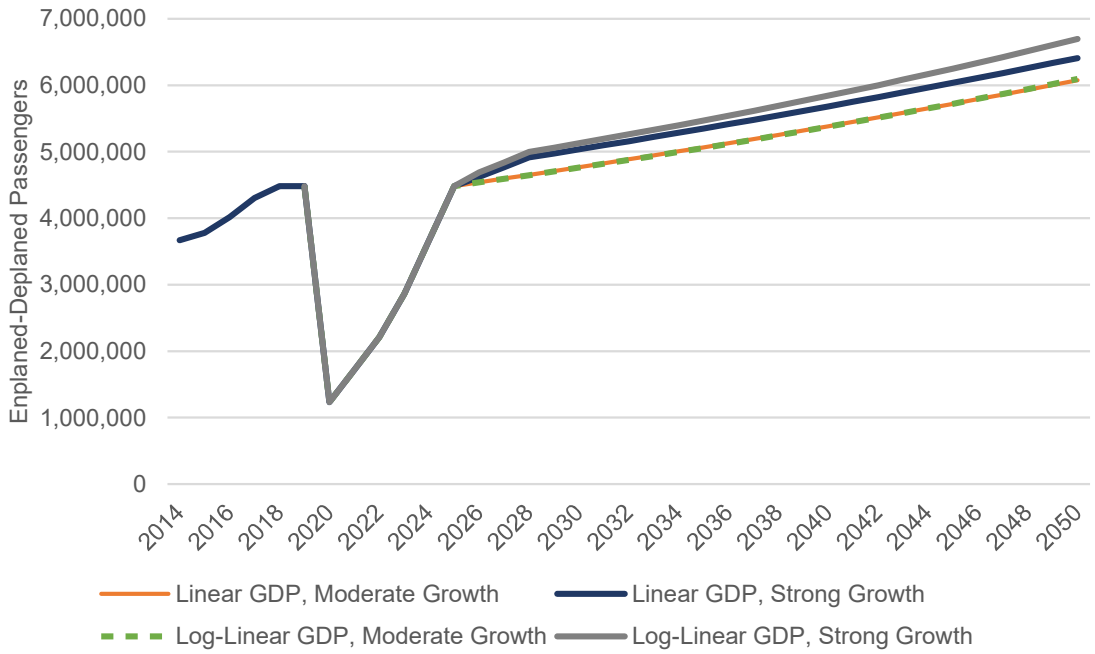
** As citied in the Talent Canada Website

For both the Linear and Log-Linear GDP passenger activity models, two forecasts are prepared illustrating Moderate and Strong Growth scenarios:

1. Moderate Growth: Anticipates that GDP increases by 2.0% in 2021 and 2022, by 1.0% in 2023, and by 1.2% in subsequent years; and
2. Strong Growth: Assumes that GDP increases at accelerated rates (3.0% annually) from 2021 to 2028 and by 1.2% annually in subsequent years. Passenger traffic is assumed to grow at increased rates following the COVID-19 recovery period due to the suppression of activity that occurred during the pandemic and pent-up demand.

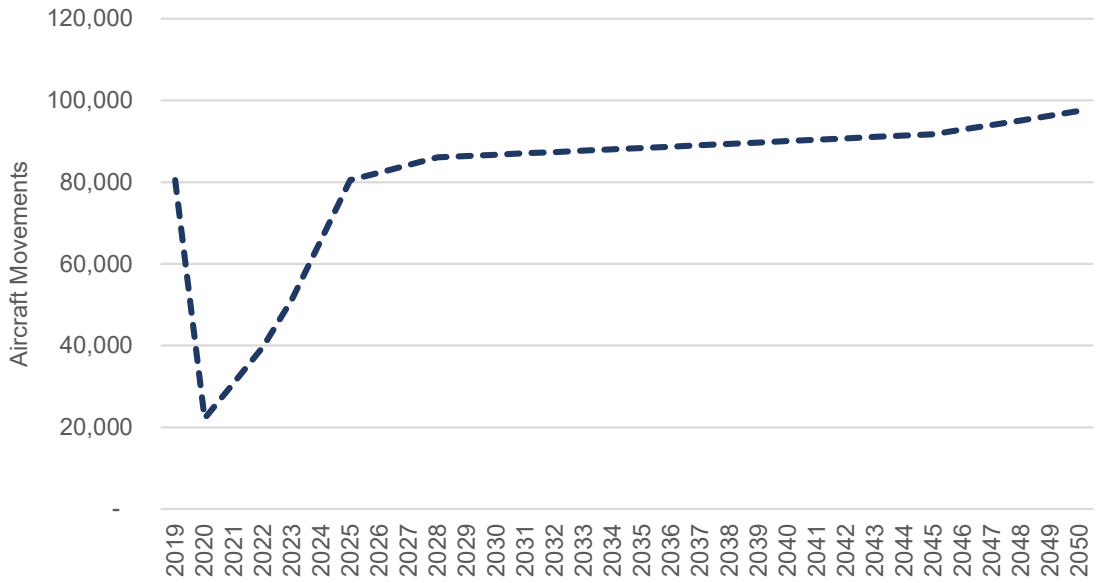
Passenger activity forecasts in the Linear and Log-Linear Moderate Growth and Strong Growth scenarios are illustrated in Figure 2.7.

Figure 2.7 - Passenger Activity Forecasts



Based on the activity forecasts shown in Figure 2.7, corresponding passenger air carrier movement forecasts have been prepared. This forecasting process is informed by an assumed increase in aircraft capacity over time from 84 seats per flight (baseline average) to 99 seats per flight in 2050, which is consistent with the historical trend of air carriers using larger aircraft. Additionally, load factors are assumed in the forecast to be held at a constant level of 85%. The Linear GDP – Strong Growth passenger air carrier movement forecast is selected for inclusion in the NEF Study forecast, as shown in Figure 2.8.

Figure 2.8 - Level I-III and Foreign Passenger Air Carrier Movement Forecast



Itinerant Cargo Air Carrier Movements (Level I-III and Foreign)

Cargo air carrier movements by Level I-III and Foreign operators such as CargoJet, FedEx, UPS, and DHL are forecast separately from passenger air carrier movements to account for the different impacts of the COVID-19 pandemic and the long-term role of Winnipeg International Airport in freight and logistics. It is understood that the air cargo sector is an area of increasing focus for the WAA given the role of Winnipeg as an inland port with extensive truck and rail distribution connections, growth in e-commerce, and increasing livestock exports. This is underscored by a $62M multi-tenant air cargo logistics facility that is planned to open in the short-term horizon, partly funded by the Federal Government's National Trade Corridors Fund.

As with passenger air services, increased air cargo throughput (tonnage) is not uniformly correlated with cargo air carrier movements. As cargo volumes grow, additional aircraft can be deployed, the load factor of existing flights can be increased towards capacity, and larger aircraft can be operated. For example, a route operated by a Boeing 757F (maximum payload of 60,000 lbs) that is experiencing growth could have:

- Two Boeing 757Fs deployed, for a total payload of 120,000 lbs; or
- One Boeing 767F substituted with a maximum payload of 120,000 lbs.

The 2019 baseline for air cargo movements was estimated using flight arrival and departure information made publicly available by the WAA. A flight-by-flight review of the database was completed to identify the number of cargo air carrier flights that occur on a daily basis, which was then multiplied assuming that each service operates five times per week, year-round. Accordingly, of the 2019 Statistics Canada total of 88,042 Level I-III and Foreign itinerant air carrier movements, 7,520 movements were estimated to be operated by cargo air carriers.

Historical data on the number of air cargo movements that occurred in previous years was not available for review by the project team; accordingly, the identification of trends over time could not be completed. Boeing, in its World Air Cargo Forecast, anticipates that Canadian domestic air cargo market may grow by 2.9% annually between 2020 and 2039, while transborder air cargo volumes may increase by 1.1% annually during the same period. Airbus, in its most recent Global Market Forecast, anticipates that air cargo may increase by 3.6% annually between 2018 and 2038, although this is a global metric that does not account for the specifics of the Canadian context. Both growth metrics measure air cargo in Freight Tonne Kilometres or Revenue Tonne Kilometres – i.e., the weight of air cargo multiplied by the distance flown. As noted previously, forecast increases in air cargo Revenue Tonne Kilometres may not correlate uniformly with increased air cargo movements as residual capacity is absorbed and / or larger aircraft are deployed.

While historical data is not available to identify trends in air cargo movements at Winnipeg International Airport over time, air cargo movements may reasonably be expected to increase at Winnipeg in the future based on:

- The favourable air cargo market outlooks published by Airbus and Boeing;
- The proactive efforts being taken by the WAA and Government of Canada in improving the air cargo infrastructure of Winnipeg International Airport; and
- Winnipeg's strength and role as an inland port and distribution centre.

Accordingly, an assumed constant annual growth rate in itinerant cargo air carrier movements (Level I-III and Foreign) of 1% has been selected by the project team and is applied from the 2019 baseline to 2050. Assuming that cargo services operate five days per week, this represents a conservative increase from approximately 29 weekday air cargo movements (15 air cargo flights per weekday) in 2019 to 40 weekday air cargo movements (20 air cargo flights per weekday) in 2050.

Itinerant Air Carrier Movements (Level IV-VI)

Winnipeg International Airport serves an important role in supporting smaller Level IV-VI air carriers. A consistent trend in movements in this category between 2001 and 2019 is not identifiable, with periods of growth to approximately 10,000 annual movements followed by declines to between 3,000 and 5,000 movements. Given the variability that is exhibited in historical itinerant Level IV-VI air carrier operations, the forecast assumes that movements in this category will be held at the 2001-2019 average of approximately 6,400 annual movements.

Itinerant Other Commercial Movements

Other commercial itinerant aircraft movements, after decreasing significantly from 2003 to 2008, have ranged over the last ten years between 400 and 700 annual movements. Itinerant movements by other commercial aircraft operators are assumed to remain at their 2010-2019 annual average of approximately 500 movements. This approach to forecasting itinerant other commercial movements is used as:

- Traffic has remained relatively stable over the past ten years;
- Continued operations may reasonably be expected to continue across the forecast period; yet
- A specific event has not been identified that may result in a significant increase in such movements.

Itinerant Private Movements

Itinerant movements by private aircraft operators are assumed to be held at their 2010-2019 annual average of 3,900 movements across the forecast horizon. This assumption is a departure from the decline in traffic exhibited from 1997 to 2019 and is reliant on Winnipeg International Airport continuing to attract a proportion of regional private itinerant traffic due to its airside infrastructure, support services, and Fixed-Base Operators.

Itinerant Government Civil Movements

Itinerant government civil aircraft movements have exhibited year-over-year variability throughout the 1997 to 2019 dataset, ranging between 3,000 and 5,000 annual movements, with an overall positive trend. Winnipeg International Airport is a significant part of the Province of Manitoba's aviation operations, including air ambulance flights, wildfire suppression, and justice transportation. While recent steps by the Province to contract these services to air carriers may change the manner in which such movements are recorded, the need for these activities are expected to remain the same and may reasonably be expected to increase over time. Accordingly, a 0.4% annual growth rate is applied based on a linear regression analysis of 1997-2019 movements in this category.

Itinerant Government Military Movements

Military traffic is assumed to remain at the annual average of 3,100 itinerant movements experienced between 2010 and 2019. This considers the permanent presence of the Royal Canadian Air Force's 17 Wing and associated units such as 402 Squadron and 435 Squadron, as well as historic instances of year-over-year increases.

Local Movements

Local aircraft movements have decreased by an average of 1.0% annually from 2010 to 2019 and have ranged between 8,700 and 13,700 annual movements in this period. The forecast assumes that local movements stabilize at the 2010-2019 average of 10,300 movements. This assumption considers that while significant new generators of local movements (e.g., a flight training unit) are not anticipated given the availability of nearby general aviation and training airports (i.e., St. Andrews Airport, Steinbach Airport, Southport Airport), a degree of activity in this category can reasonably be expected to continue.

2.2.4 Forecast Results

Based on the assumptions described above, forecasted changes in itinerant, local, and total aircraft movements are shown in Figure 2.9, Table 2.6, and Table 2.7. Aircraft movements at Winnipeg International Airport are forecast to recover to pre-COVID (2019) levels between 2024 and 2025 before increasing by an annual average of between 0.4% and 1.0% to 2050. Based on these assumptions, approximately 137,000 annual movements are forecast to occur in 2050, reversing approximately 20 years of annual decreases are returning to 2012 activity levels.

Figure 2.9 - Aircraft Movement Forecast

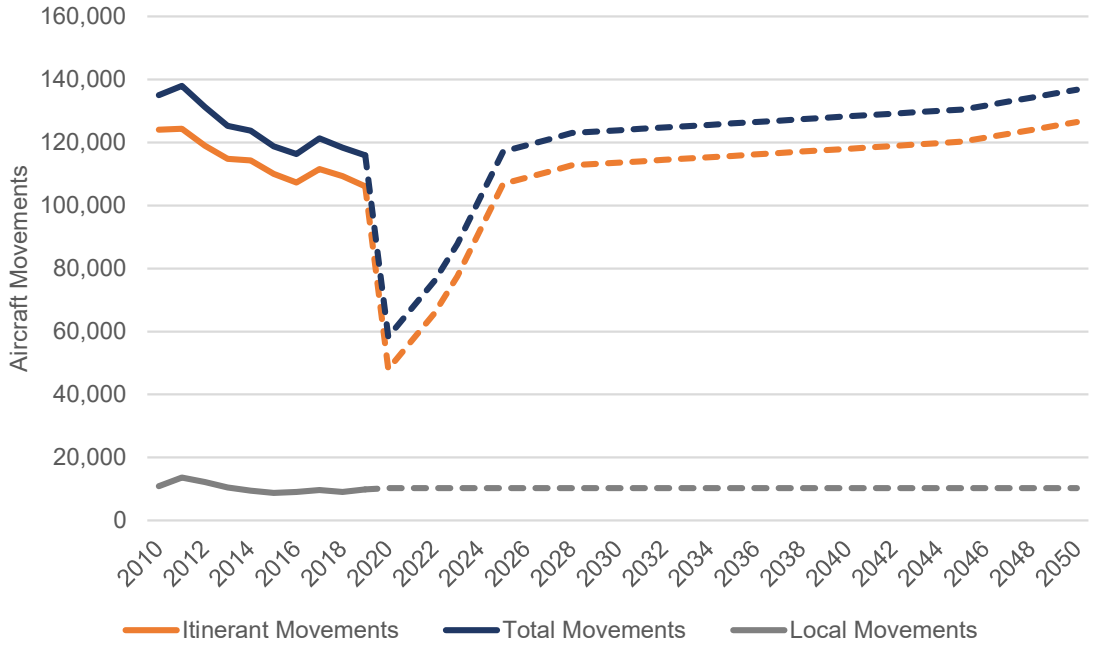


Table 2.6 - Aircraft Movement Forecast

Year	Local	Itinerant	Total
Historical Aircraft Movements			
1997	25,049	130,172	155,221
2000	17,640	137,036	154,676
2005	7,609	129,327	136,936
2010	10,846	124,114	134,960
2015	8,710	110,094	118,804
2019	9,840	106,088	115,928
Forecast Aircraft Movements			
2020	10,294	48,006	58,300
2025	10,294	106,866	117,610
2030	**10,294**	**113,578**	**123,872**
2035	10,294	115,750	126,044
2040	10,294	117,966	128,260
2045	10,294	120,227	130,521
2050	**10,294**	**126,508**	**136,801**

Table 2.7 - Forecast Average Annual Growth Rates

Period	Average Annual Change
Historical Aircraft Movements	
1997-2010	-1.0%
2011-2019	-2.0%
Forecast Aircraft Movements	
2019-2025	0.2%
2026-2030	1.0%
2031-2035	0.4%
2036-2040	0.4%
2041-2045	0.4%
2046-2050	1.0%

3 RUNWAY CAPACITY ANALYSIS

3.1 Purpose

The capacity of an airfield is defined as the number of aircraft movements that can be accommodated within a given timeframe – typically, capacity is calculated on an hourly, daily, and / or annual basis. In the context of this report, the capacity of Winnipeg International Airport is analyzed solely with respect to runway capacity, omitting the consideration of taxiway, apron, and terminal building metrics. Capacity can be further defined as:

- **Maximum Throughput Capacity:** The theoretical number of aircraft movements that can occur in a timeframe without operational disruptions – for example, without temporary runway closures to retrieve debris, snow clearing, and wildlife management.
- **Practical Capacity:** The number of aircraft movements that can occur given the existence of disruptions (e.g., inclement weather conditions) without significant delays.

The purpose of calculating the capacity of the runway system in the NEF Study is twofold:

1. To assist the Province of Manitoba in determining whether runway demand, in terms of annual aircraft movements, is likely to exceed available capacity and whether an additional runway may be required within the 30-year horizon (2050) of this study; and
2. To inform the preparation of the 'ultimate-term' noise contour set, which considers the maximum utilization of Winnipeg International Airport including the addition of a new runway.

The runway system capacity analysis is based on the independent analysis of the project team and should not be interpreted as representing the position of the WAA, NAV CANADA, or other parties. Further, the intent of the analysis is not to make a definitive conclusion as to whether a new runway may be required at Winnipeg International Airport, but instead to assist the Province in selecting an appropriate set of noise contours for future land use policy development and implementation.

3.2 Previous Studies

The following publicly available studies were reviewed by the project team to inform the capacity analysis.

3.2.1 2000 Airport Development Plan Summary

The WAA 2000 Airport Development Plan Summary included a forecast of Planning Peak Hour Aircraft Movements, which is calculated as the average demand of the ten busiest hours for each of the three busiest months of the year. The 2000 Airport Development Plan Summary forecasted that the Planning Peak Hour Aircraft Movements for Visual Flight Rules (VFR) operations would increase from 43 movements in 1999 to 60 movements in 2020, with the Instrument Flight Rules (IFR) Planning Peak Hour Aircraft Movements increasing from 34 to 50 movements in the same period. The report also stated that:

> *"There is sufficient airside capacity overall, but by the end of the planning period forecast demand will exceed 90% of total capacity, which may result in congestion and delays."*

While the report forecasted that annual aircraft movements would increase from 157,000 in 2000 to 227,000 in 2020, actual activity in 2019 was approximately 116,000 total aircraft movements. Accordingly, it may be inferred that residual capacity exists on an annual basis based on this statement.

3.2.2 Winnipeg Richardson International Airport – Master Plan 2033

Master Plan 2033 was published by the WAA in June 2015, with the Land Use Plan subsequently approved by Transport Canada in September 2015. As noted in Section 2.2, this report includes aircraft movement forecasts to 2033 that were prepared in December 2013 and subsequently updated in 2014.

The WAA completed a robust analysis of airside system capacity as part of the 2033 Master Plan which found that the airfield, in its 2013 configuration, had a practical annual capacity of approximately 204,000 aircraft movements. The report also found that depending on the operational scenario, hourly capacity ranged from 6 aircraft movements in IFR Category II Instrument Landing System operations to 44 aircraft movements during VFR simultaneous intersecting runway operations.

The report found that sufficient capacity should exist to meet the most likely aircraft movement forecast (167,500 movements in 2033), and that demand in the high aircraft movement forecast (194,300 movements in 2033) could result in significant and frequent delays beyond five minutes. A range of capacity enhancement measures, which are outlined in Section 3.5, would improve annual capacity to approximately 227,000 annual movements if implemented.

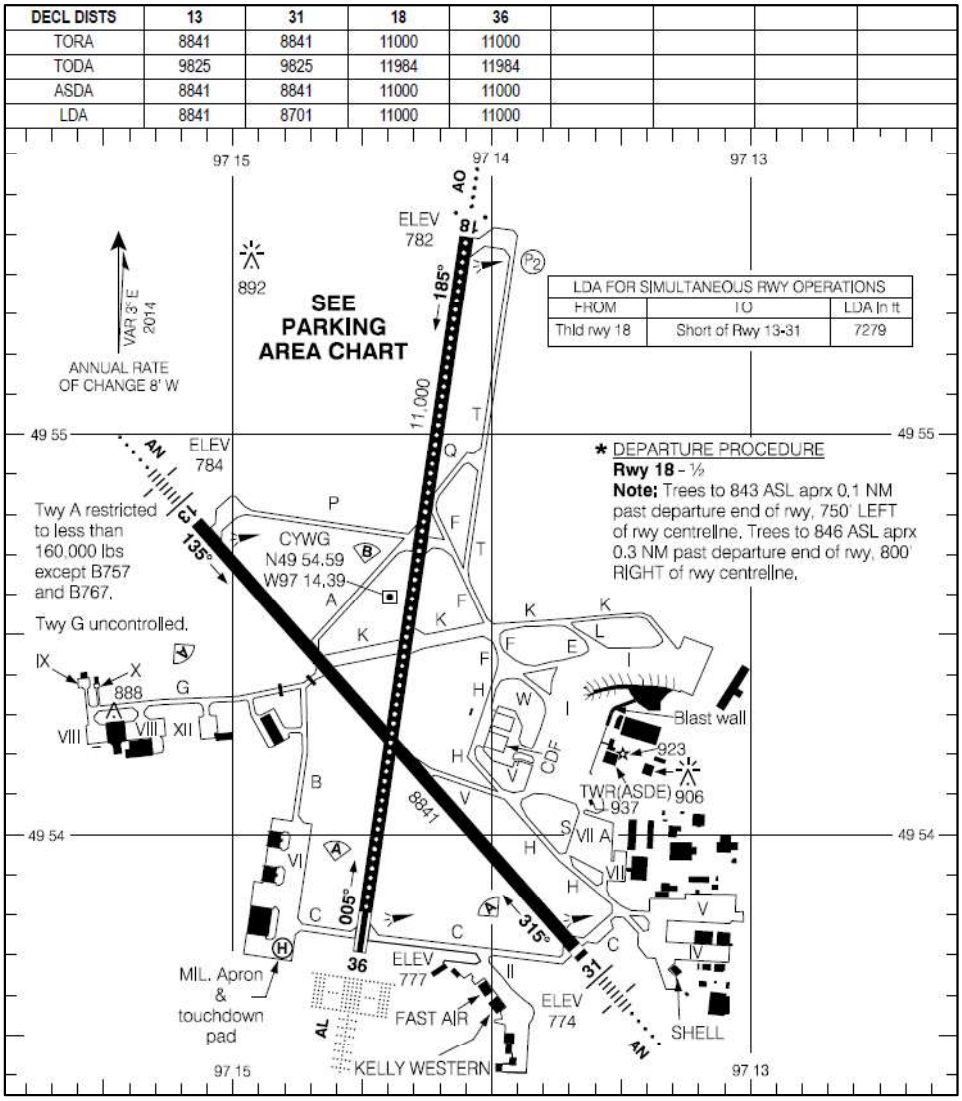
3.3 Analysis Model

The baseline and ultimate-term runway capacity analyses have been completed using the Prototype Airfield Capacity Model (PACM) developed by the U.S. Airport Cooperative Research Program. The PACM is a spreadsheet-based analysis tool that can be used to develop simplified calculations of hourly aircraft movement capacity – given the level of input data available to the project team and the two purposes of the analysis, the use of this tool is considered appropriate.

3.4 Baseline Runway Capacity

The baseline capacity of Winnipeg International Airport is examined in terms of its hourly capacity and estimated annual capacity. The baseline capacity analysis considers the infrastructure of Winnipeg International Airport as it exists in 2020, as shown in Figure 3.1. Category II Instrument Landing System operations are not modelled as additional data is required from NAV CANADA and the WAA to inform the analysis of throughput during such conditions. Category II Instrument Landing System operations significantly lower hourly capacity levels; however, such operations are understood to generally occur infrequently at Winnipeg International Airport.

Figure 3.1 - Baseline Capacity Analysis Airfield Layout (NAV CANADA)



3.4.1 Assumptions

General Assumptions

The primary PACM assumptions are as follows:

- **Meteorological Conditions:** The proportion of operations that occur in Visual Meteorological Conditions (VMC) and Instrument Meteorological Conditions (IMC). For the purpose of this analysis, VMC is defined as the percentage of time where the cloud ceiling is at least 1,000 ft. Above Ground Level and the visibility is at least 3 Statute Miles. Based on a review of the NAV CANADA Local Area Manual, the prevalence of VMC is conservatively estimated at 85% and IMC at 15%. Generally, capacity improves in VMC and decreases in IMC.
- **Aircraft Departure – Arrival Separation:** The minimum spacing between an arriving aircraft and the runway threshold for a departure to be cleared to take-off. This has been estimated at 2.5 Nautical Miles (NM) in VMC and 3.0 NM in IMC.

- **Length of Common Approach:** The distance from the outer marker, where an aircraft is typically on final approach, to the runway threshold, estimated at 5 NM.
- **Touch and Go Factor:** The proportion of movements that are assumed to be aircraft landing and taking off again as a "touch and go" movement – typically, this is part of initial and recurrent pilot training. The touch and go factor increases the number of movements that can be accommodated given the lower runway occupancy time of each movement. To estimate the capacity of Winnipeg International Airport more conservatively, this has been assumed at 0%.
- **Operating Fleet Mix:** The proportion of aircraft movements that occur across seven categories. The categories and assumed proportions are shown in Table 3.1, based on the analysis of the 2019 NAV CANADA Aircraft Movements dataset for itinerant traffic. The proportional accuracy of each category may vary as local aircraft movement types could not be accounted for.
- **Arrival Runway Occupancy Time:** The length of time that an arriving aircraft occupies a runway before exiting. The default values determined by the Airport Cooperative Research Program are used in the analysis, as shown in Table 3.1.
- **Average Approach Speeds:** The velocity in knots that an aircraft approaches the runway while on final approach. The default Airport Cooperative Research Program values are carried forward in the analysis, as shown in Table 3.1.
- **Runway Exit Availability:** A selection-based capacity factor that considers the availability of taxiways for aircraft exiting the runway. The options included in the PACM are Insufficient (no exits), Poor (1 exit), Good, (2-3 exits), and Excellent (4 or more exits). The "Good" selection is assumed in all baseline analyses accounting for the differing conditions between Runways 13-31 and 18-36, non-optimized configuration of select exits, and deficiencies noted in the WAA's Master Plan 2033.
- **Air Traffic Control Services:** Whether air traffic control services are provided to manage traffic, separate aircraft, and optimize runway utilization. Air traffic control services are provided by NAV CANADA at Winnipeg International Airport.
- **Runway Crossing Demand:** Whether aircraft arrival and departure delays will occur as a result of aircraft crossing the runway. No runway crossing delays are modelled.
- **Arrival / Departure Mix:** Where possible, PACM inputs have been adjusted to achieve a 50% split between arrivals and departures. This is intended to model operations outside of peak arrival and departure windows where higher throughput may be achieved as a result of streamlined operations.

In addition to the primary inputs noted above, the Airport Cooperative Research Program's default values are also used for the following options: Arrivals Deceleration Rate (5.3 ft / sec^2), Departures Acceleration Rate (8.0 ft / sec^2), Arrival – Arrival Standard Deviation (18 seconds between aircraft), and Departure Release Standard Deviation (6 seconds).

Table 3.1 - Baseline Capacity Analysis Fleet Assumptions

Aircraft Category	Small-S	Small-T	Small+	Large-TP	Large-Jet	Large-757	Heavy
Maximum Take-Off Weight / Notes	< 12,500 lbs, single-engine	< 12,500 lbs, twin-engine	12,500 lbs to 41,000 lbs	41,000 lbs to 255,000 lbs, turboprop	41,000 lbs to 300,000 lbs, jet	Boeing 757 Series	> 300,000 lbs
Proportion of Movements (%)	3.0%	3.0%	34%	12.5%	41.6%	2.7%	3.2%
Arrival Runway Occupancy Time (sec.)	32	40	42	45	46	51	55
Average Approach Speed (kts.)	90	100	120	130	135	140	150

Runway Capacity Scenarios

The hourly capacity analysis considers runway throughput in cases where:

- Winds from the north favour the use of Runway 36 for mixed operations (arrivals and departures) and Runway 31 for departures; or
- Winds from the south favour the use of Runway 18 for mixed operations (arrivals and departures) and Runway 13 for arrivals.

This analysis does not account for:

- Land and Hold Short Operations, where VFR aircraft landing on Runway 18 hold short of Runway 13-31 while the latter runway is also in use. Land and Hold Short Operations are anticipated to increase the hourly movement capacity; and
- Instrument Landing System Category II operations, which are limited to Runway 36.

3.4.2 Outputs

Based on the assumptions noted in Section 3.4.1, runway capacity is estimated at 41 hourly movements for IFR operations and 44 hourly movements for VFR operations.

The annual capacity of Winnipeg International Airport is calculated assuming full operations occur from 7:00 AM to 11:00 PM, outside of the overnight hours subject that are subject to operational restrictions as part of the published noise abatement procedures. As shown in Table 3.2, the baseline maximum throughput capacity of Winnipeg International Airport is estimated at 253,000 annual movements. However, as noted in Section 3.1, practical capacity is a more reasonable metric that accounts for the imperfections of airport operations, weather, variability in pilot behaviour and other matters. Practical capacity is estimated at 80% to 90% of maximum throughput capacity. Accordingly, the practical capacity (80% to 90% of maximum throughput capacity) of Winnipeg International Airport is estimated to be between 203,000 and 229,000 annual aircraft movements.

As described in Section 2.2.4, the aircraft movement forecast estimates that 137,000 annual aircraft movements may occur by 2050. Based on the consideration of forecast annual aircraft movements (137,000) versus the practical capacity of the runway system (203,000 to 229,000 annual movements), sufficient residual runway capacity is expected to exist in 2050 as illustrated in Figure 3.2.

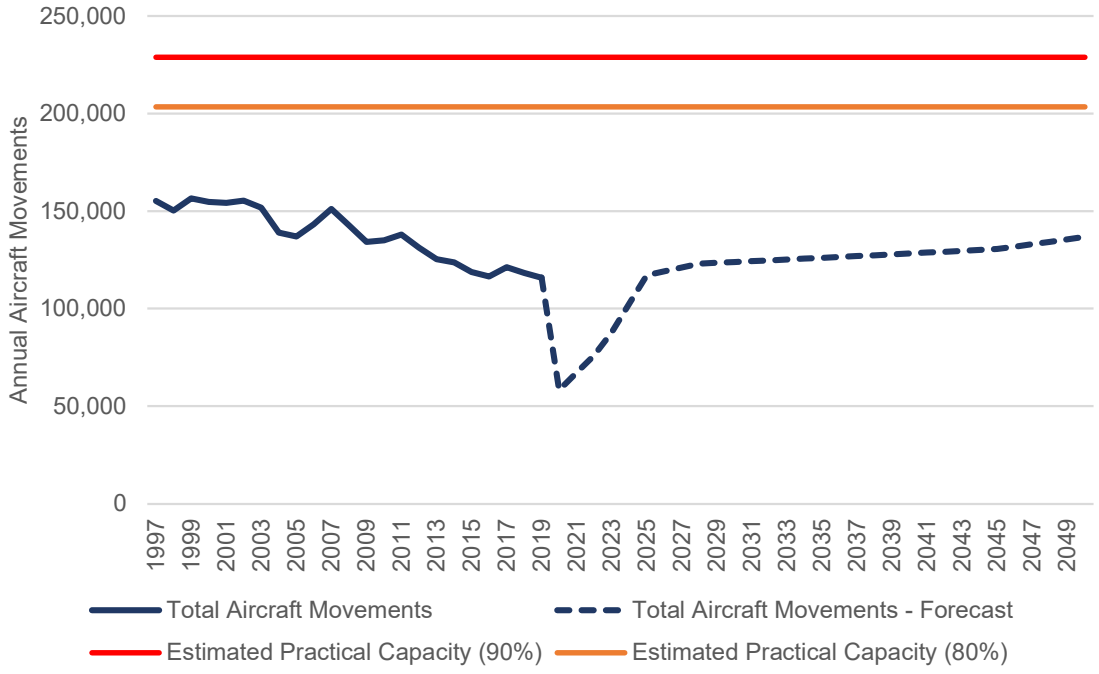
Table 3.2 - Baseline Annual Capacity Estimate

Scenario	Hourly Movement Capacity		Annual Movement Capacity	
	IMC	VMC	Maximum Throughput Capacity	Practical Capacity
Runway 18-36 / Runway 13-31 Operations	41	44	254,000	229,000 – 203,000

Notes:

- Visual Meteorological Conditions are assumed to prevail for 85% of the year
- Instrument Meteorological Conditions are assumed to prevail for 15% of the year
- Capacity is calculated based on a 16-hour day
- Practical capacity is estimated to be between 80% and 90% of maximum throughput capacity

Figure 3.2 - Estimated Practical Capacity vs. Forecast Aircraft Movements



Assuming a 1.0% constant annual growth rate for total aircraft movements continues indefinitely beyond the 2050 forecasting horizon, practical annual capacity (203,000 movements) could be reached in 2090. This metric is provided for discussion purposes only at the request of the Province, as the extended horizon (70 years) of such an estimate affects its accuracy. Further, the capacity of the airfield may be reached prior to 2090 based on constraints during peak hour airport activity and / or growth rates that exceed those modelled in this report.

3.5 Capacity Enhancement Measures

Several measures can be implemented to increase the runway capacity of Winnipeg International Airport, including:

- Taxiway projects by the WAA to optimize the use of the existing Runways 18-36 and 13-31;
- Improved operational procedures that optimize the use of the existing runways, such as modified air traffic procedures by NAV CANADA; and
- The addition of a new runway by the WAA.

The WAA's Master Plan 2033 outlines strategic opportunities for improving runway system capacity, which are shown in Figure 3.3 and include:

- A taxiway serving Runway 13 between Taxiway V and Taxiway C;
- A taxiway serving Runway 18 between Taxiway K and Runway 13-31;
- The extension of Taxiway T parallel to Runway 18-36; and
- The development of a parallel taxiway serving Runway 13-31.

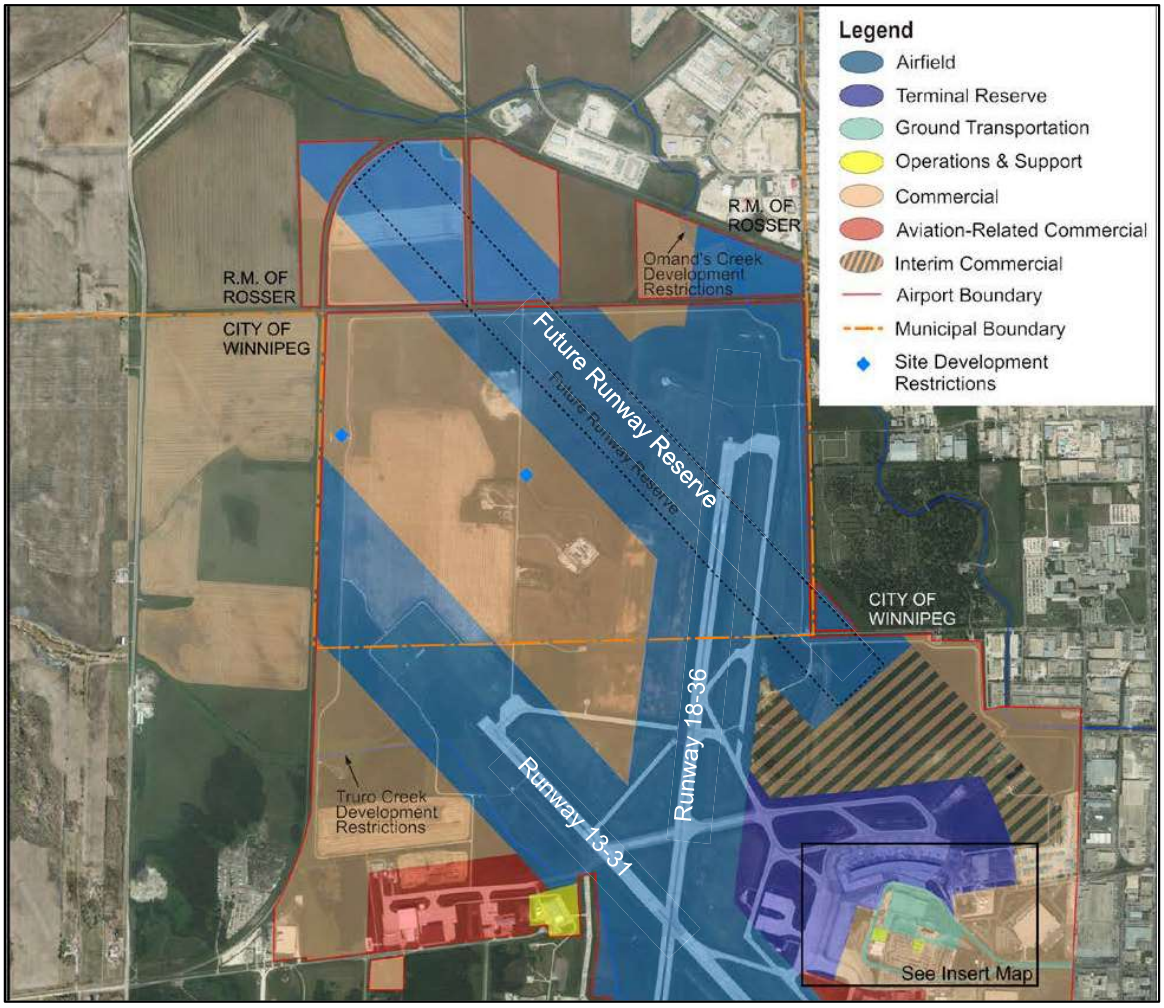
The capacity improvement implications of these projects have not been modelled by the project team given the identification of sufficient residual runway capacity to 2050. However, the Master Plan notes that the baseline annual airfield capacity modelled by the WAA (204,000 movements) could be increased to approximately 227,000 movements with the implementation of these measures. Similarly, improvements in peak hour capacity would be realized.

Master Plan 2033 includes a Land Use Plan that was approved by Transport Canada in 2015. As shown in Figure 3.4, sufficient land is reserved at the north side of the airport for a future runway parallel to Runway 13-31, which would increase the hourly and annual airfield capacity. The Master Plan makes the following note with respect to the parallel runway reserve:

> *"Note that the parallel runway length and position has not been determined and is not anticipated to come into use during this Master Plan timeframe."*

Figure 3.3 - Airfield Capacity Improvement Measures (WAA Master Plan 2033)

Figure 3.4 - 2033 Airport Land Use Plan (WAA Master Plan 2033)



3.6 Ultimate-Term Runway Capacity

As described above, the practical runway system capacity of Winnipeg International Airport is estimated at between 203,000 and 229,000 annual movements by HM Aero and at 204,000 annual movements by the WAA in their 2033 Master Plan. Considering this, the runway capacity is anticipated to be adequate to 2050 or later based on the aircraft movement forecasts prepared as part of this study. Additionally, the implementation of select capital projects has the potential to improve the utilization of the airport's existing runways by decreasing runway occupancy times for arriving aircraft and by rationalizing the movement of aircraft across the taxiway network. Based on the WAA's Master Plan 2033, these projects could increase annual capacity by approximately 23,000 movements. In addition, future technologies in aircraft navigation may reduce aircraft separation requirements on approach and departure, further increasing runway capacity at Winnipeg International Airport.

Notwithstanding the foregoing, sufficient land continues to be reserved at the north side of the airport for a new runway up to approximately 10,000 ft. in length, parallel to the existing Runway 13-31. The potential parallel runway is protected at the federal level by the Winnipeg International Airport Zoning Regulations (SOR/81-708), enacted by the Governor in Council per the recommendation of the Minister of Transport in 1981, and by Master Plan 2033's Land Use Plan that was approved by the Minister of Transport in 2015. The inclusion of the parallel runway reserve in the Transport Canada-approved Land Use Plan indicates that the federal government, as the landowner of Winnipeg International Airport, has a long-term interest in protecting for such a facility in the future if sufficient demand exists to require the capacity improvements that would be realized.

While the study supporting the development of the 1995 NEF contours that form the basis of the AVPA Secondary Plan was not available for review by the project team, a visual review of the contours indicates that the noise implications of the potential parallel runway were modelled. Additionally, the size of the 1995 NEF contours suggest that the 95th percentile planning day input may have been based on the maximum throughput capacity of the runway system – however, this cannot be confirmed by the project team. HM Aero has prepared an independent estimate of the ultimate-term runway capacity at the direction of the Province of Manitoba, which will subsequently inform a noise contour scenario.

3.6.1 Assumptions

General Assumptions

In addition to the assumptions previously stated in Section 3.4.1, the following PACM inputs are provided with respect to the parallel runways:

- The runway centrelines are parallel and separated by 4,800 ft;
- Both runways can be used independently in both VMC and IMC;
- Departure routes diverge by at least 15 degrees; and
- Runway exit availability is set at "Excellent" assuming that all possible taxiway improvements to the existing runways are implemented prior to the development of a new parallel runway, and that the new runway has an optimized taxiway system.

Runway Capacity Scenarios

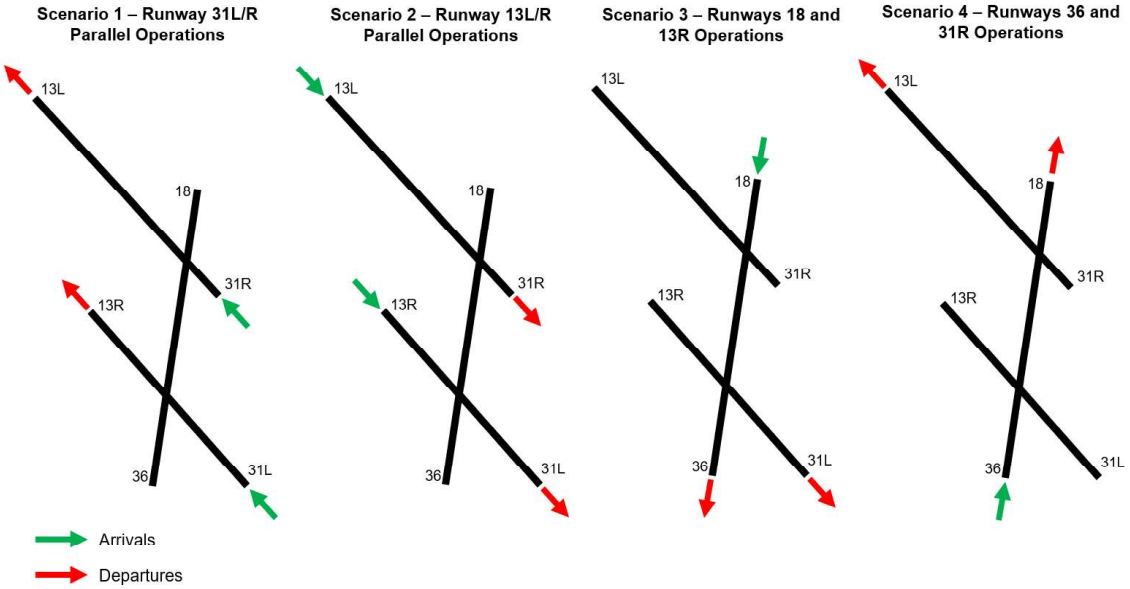
As noted above, the ultimate-term capacity analysis considers both the current Runway 18-36 and 13-31 (subsequently referred to as Runway 31 Left (L) – Runway 13 Right (R)) and the potential parallel Runway 13L-31R. Planning data on the potential operations of Winnipeg International Airport with the addition of Runway 31R-13L was not made available to the project team. The utilization of each runway in the future will be subject to a range of factors such as:

- Wind and meteorological conditions;
- Peak period demands (e.g., peak-period arrival and departure "rushes"); and
- Noise abatement procedures limiting overflights of sensitive areas.

Hourly runway capacity values were calculated for four operational scenarios that reflect the potential uses of the ultimate-term runway system, as shown in Figure 3.5 and summarized as follows:

1. **Runway 31L / 31R Parallel Operations:** The independent use of both parallel runways for mixed operations, with arrivals from the southeast and departures to the northwest;
2. **Runway 13L / 13R Parallel Operations:** The independent use of both parallel runways for mixed operations, with arrivals from the northwest and departures to the southeast;
3. **Runways 18 and 13R Operations:** The use of Runway 18 for arrivals from the north and departures to the south, and the simultaneous use of Runway 13R for departures to the southeast; and
4. **Runways 36 and 31R Operations:** The use of Runway 36 for arrivals from the south and departures to the north, and the simultaneous use of Runway 31R for departures to the northwest.

Figure 3.5 - Ultimate-Term Capacity Analysis Operational Scenarios



To approximate the proportions of the year in which each of the four operational scenarios could be used, data from 2017 to 2018 was reviewed to identify the proportion of historical itinerant movements that utilized Runway 18-36 and Runway 13-31 (Table 3.3). Based on this data, the assumption was made that the historical proportional utilization of Runway 18-36 will continue in the future, represented as Scenarios 3 and 4. The proportional 2017-2018 utilization of Runway 13-31 is used as a proxy to estimate the use of the parallel runways in Scenarios 1 and 2.

Table 3.3 - 2017-2018 Runway Utilization

Operations	Runway				Total
	18	36	13	31	
Departures	25%	29%	8%	37%	100%
Arrivals	33%	28%	11%	28%	100%
Average (Departures and Arrivals)	29%	28%	10%	33%	100%

3.6.2 Outputs

The hourly movement capacity of Winnipeg International Airport is expected to vary based on the operational scenario in effect at a given time. As shown in Table 3.4, a maximum of 110 hourly VFR aircraft movements are estimated to be accommodated when the parallel runways are in use (Scenarios 1 and 2). This capacity is estimated to decrease to between 59 and 74 hourly VFR aircraft movements when either Runway 18 or Runway 36 is in use with secondary operations on Runway 13L-31R or Runway 13R-31L.

Consistent with the baseline capacity analysis, the ultimate-term capacity analysis calculates annual capacity assuming that full operations occur from 7:00 AM to 11:00 PM. As shown in Table 3.4, the ultimate-term maximum throughput capacity is estimated at 489,000 annual aircraft movements. The practical capacity, approximated at between 80% and 90% of maximum throughput capacity, is estimated to be between 392,000 and 441,000 annual aircraft movements.

Table 3.4 - Ultimate-Term Annual Capacity Estimate

Scenario	Proportion of Annual Operations	Hourly Movement Capacity		Annual Movement Capacity	
		IMC	VMC	Maximum Throughput Capacity	Practical Capacity
1 – Runway 31L/R Parallel Operations	33%	98	110	209,000	167,000 – 188,000
2 – Runway 13L/R Parallel Operations	10%	98	110	63,000	51,000 – 57,000
3 – Runways 18 and 13R operations	29%	53	59	98,000	79,000 – 89,000
4 – Runways 36 and 31R Operations	28%	66	74	119,000	95,000 – 107,000
			TOTAL	489,000	392,000 – 441,000

Notes:

- Visual Meteorological Conditions are assumed to prevail for 85% of the year
- Instrument Meteorological Conditions are assumed to prevail for 15% of the year
- Capacity is calculated based on a 16-hour day
- Practical capacity is estimated to be between 80% and 90% of maximum throughput capacity

4 NOISE CONTOUR CALCULATIONS

4.1 Methodology

Noise contours (NEF, NEP, or Planning Contours) are developed using a structured process through the NEFcalc software system that was developed by Transport Canada and the National Research Council. The software was most recently updated to NEFcalc Version 2.0.6.1 in 2011, which is the version used for the generation of the contours presented in this study.

Noise contours are representative of a near to worst-case 24-hour period and are based on the number of aircraft operations for a Peak Planning Day. As defined by Transport Canada, the Peak Planning Day is a 95th percentile day, where only 5% of the days of the year have more aircraft movements than this day.

NEFcalc uses an embedded database of aircraft types and their associated perceived noise levels, as a function of the phase of flight and the distance from the flight path. This data is combined with inputs such as aircraft types, flight paths, distance to destination, and time of day. The software defines nighttime operations as arrivals or departures between 10:00 PM and 7:00 AM and assigns an impact of approximately 10 times the impact of daytime movements.

The NEF contour development process includes seven primary steps:

1. Define the runway configuration, lengths, orientation, and location.
2. Define the arrival and departure paths for each runway, using appropriate air traffic control procedures to ensure integration with the existing airspace system and navigation aids.
3. Calculate the utilization of each runway based on historical or forecast aircraft movement data.
4. Based on historical or forecast aircraft movement data, identify the 95th percentile busiest day. For each aircraft movement in the 95th percentile busy day, assign an aircraft type, destination distance, time of day, and runway used.
5. Enter the data in NEFcalc and complete the calculations.
6. Export the calculated contours in the appropriate scale and geographic orientation and location for further use.
7. Overlay the contours on geo-referenced mapping of the airport.

The steps followed by the project team are consistent with the methodology documented within NEFcalc Version 2.0.6.1 and with the guidance presented in Transport Canada's NEF Microcomputer System Users Manual – TP6907E (June 1990).

4.2 Model Inputs

The following inputs were utilized in the preparation of the baseline noise contours and subsequent scenarios:

- Winnipeg International Airport NAV CANADA Aircraft Movement Statistics (NCAMS) datasets for the years 2017, 2018, and 2019 provided by Statistics Canada;
- Aircraft movement forecasts for 2020 to 2050 (Section 2.2); and
- The ultimate-term runway capacity estimate of Winnipeg International Airport (Section 3.6).

4.3 General Assumptions

A series of general assumptions were made that support the preparation of all noise contour scenarios described in Section 5. Assumptions specific to the individual scenarios are described separately in Section 5.

1. Based on Statistics Canada's definition of a local movement at a controlled airport, it is assumed that all local movements are aircraft that remain in the airport traffic pattern.
2. Aircraft movements recorded in the NCAMS datasets that do not make use of one of Winnipeg International Airport's runways are excluded. This includes movements such as non-runway movements (e.g., a helicopter landing on an apron), off-site movements (e.g., a helicopter landing at the Winnipeg Health Sciences Centre), and aircraft transiting through the control zone.
3. Helicopter movements at Winnipeg International Airport were not included in the NEF calculations as:
    - The analysis of the 2019 95th percentile busy day found no helicopter movements associated with Runway 18-36 or Runway 13-31. A review of the NCAMS data found that helicopter movements associated with Runways 13-31 and 18-36 accounted for a total of 27 movements in 2019;
    - Most helicopter movements that occurred at Winnipeg International Airport were either originating from or destined to fixed points on the airport (i.e., helipads and aprons) and did not make use of the runways. These movements do not typically follow standard arrival and departure routings and therefore cannot be reliably included in the model; and
    - The NEFcalc software does not include noise data for helicopter aircraft types, requiring a user to identify a fixed-wing proxy aircraft.
4. In some instances, there are multiple Instrument Flight Procedures published for an individual runway. NCAMS data does not include the Instrument Flight Procedure, if any, that was assigned to an aircraft movement. For this reason, approach and departure paths were modelled as straight-in and straight-out, respectively.
5. Threshold coordinates for Runways 13, 31, 18, and 36 (including displaced thresholds where appropriate) were identified using data provided by the WAA and supported by inference from aerial imagery.

5 NOISE CONTOUR SCENARIOS

Noise contours for historical traffic in 2019; forecast traffic in 2033 and 2050; and activity in a conceptual ultimate-term have been prepared based on the general assumptions presented in Section 4.3 and the scenario specific assumptions presented in Sections 5.1 through 5.4.

5.1 Scenario 1 – 2019 Baseline Conditions

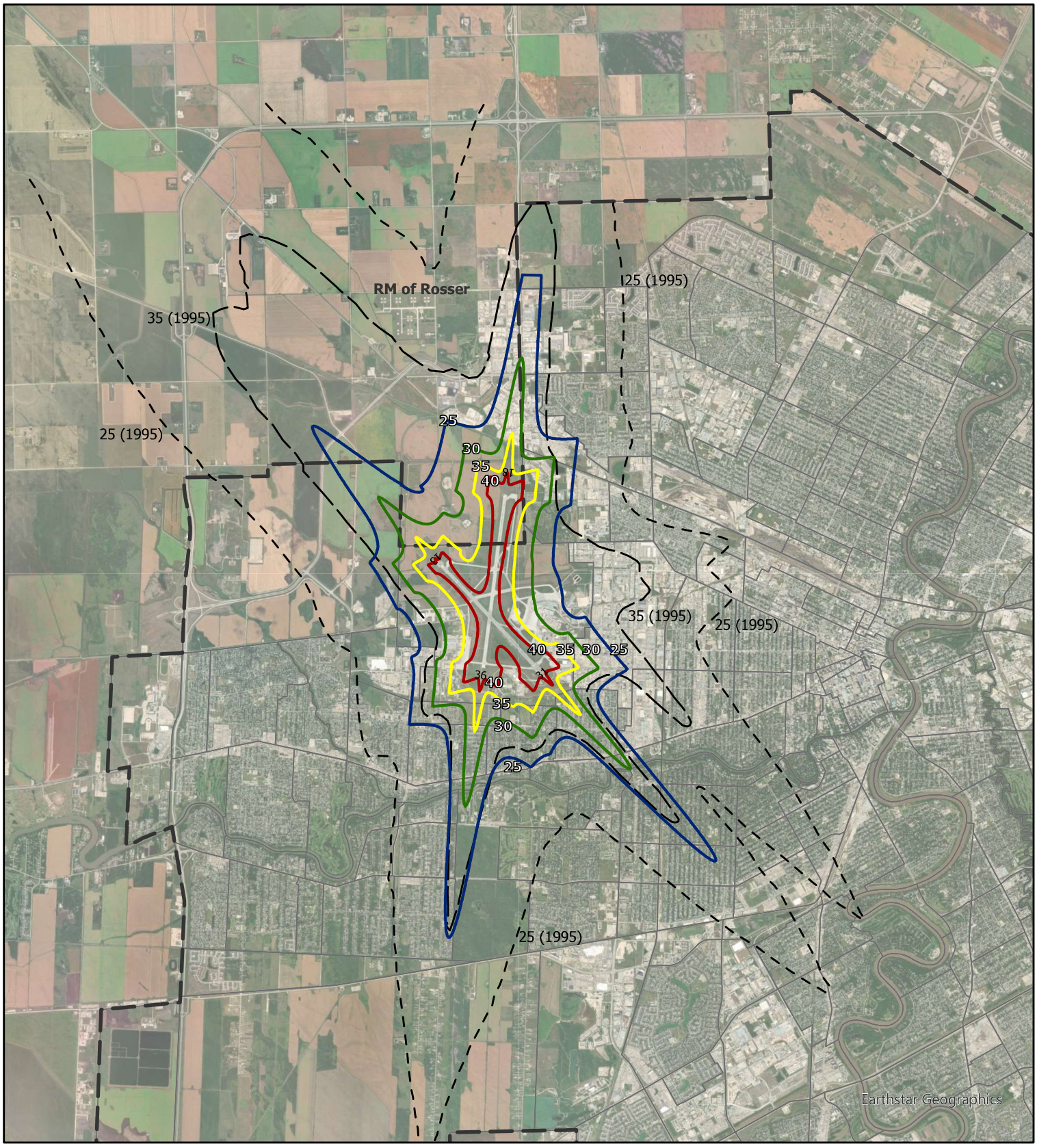
The 95th percentile busy day for 2019 consisted of 22 local movements and 336 itinerant movements, for a total of 358 movements. The general assumptions presented in Section 4 and the scenario specific assumptions provided below were applied in the preparation of the 2019 baseline noise contours. The resulting noise contours for 2019 are presented as Figure 5.1.

Scenario Specific Assumptions

1. For the baseline scenario, the itinerant aircraft types, destinations (flight ranges), and aircraft movement values required as inputs in NEFcalc were drawn from the 2019 NCAMS dataset as being representative of planning day types and destinations.
2. Representative aircraft were selected to serve as the three aircraft types defined in the 2019 NCAMS local movement data – single engine, twin engine, and jet/turbofan.
3. 2019 runway utilization statistics represented an atypical year and differed significantly from 2017 and 2018 values as a result of the temporary closure of Runway 13-31 for its rehabilitation. For this reason, 2018 runway utilization proportions were applied to the 2019 95th percentile busy day as shown in Table 5.1.

Table 5.1 - 2018 Runway Utilization

Runway	13	31	18	36
Percent Utilization	10%	33%	29%	28%



NOISE EXPOSURE FORECAST STUDY - WINNIPEG INTERNATIONAL AIRPORT

FIGURE 5.1 - 2019 BASELINE CONTOURS

JULY 2021

HM AERO AVIATION CONSULTING

Landmark Planning & Design Inc.

NEF25 — 1995 NEF25

NEF30 — 1995 NEF35

NEF35 — City of Winnipeg Limits

NEF40

1 0.5 0 1 2 3 4 Kilometers

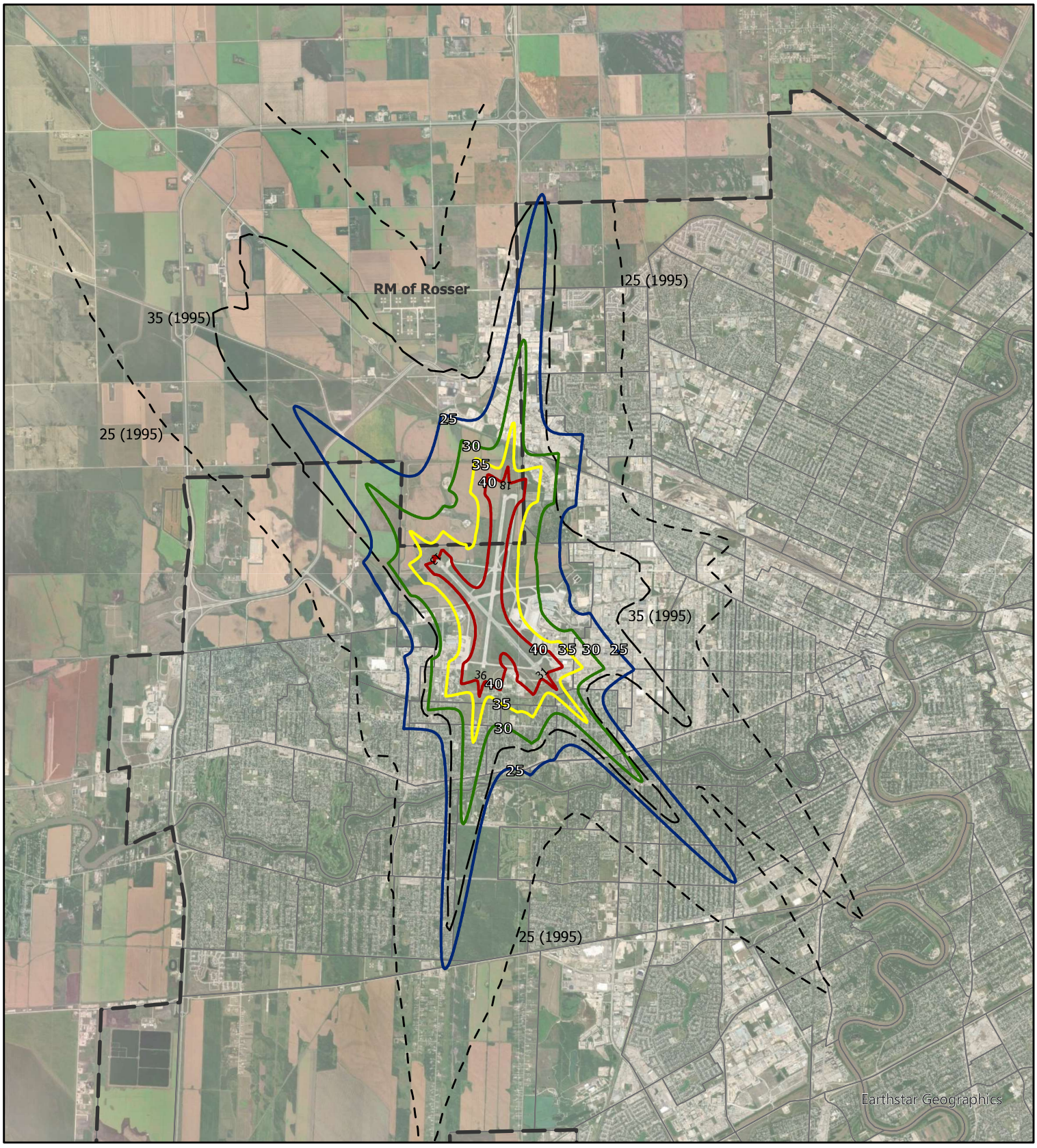
N

5.2 Scenario 2 – 2033 Forecast Conditions

Based on the aircraft movement forecasts presented in Section 2, the 95th percentile busy day for 2033 is assumed to consist of 24 local movements and 363 itinerant movements, for a total of 387 movements. The resulting noise contours for 2033 are presented in Figure 5.2.

Scenario Specific Assumptions

1. The runway utilization percentages used in the preparation of Scenario 1 contours are assumed to be representative of typical operations and were utilized in the preparation of the Scenario 2 noise contours.
2. The forecast aircraft movement growth rate was applied to the 2019 95th percentile busy day, resulting in the same proportion of aircraft types, flight paths, ranges, and day/night split as 2019, but with forecast aircraft movements representative of 2033.
3. As described in Section 3.4, the construction of a new parallel runway is not modelled in Scenario 2 – 2033 Forecast Conditions.



NOISE EXPOSURE FORECAST STUDY - WINNIPEG INTERNATIONAL AIRPORT

FIGURE 5.2 - 2033 CONTOURS

JULY 2021

HM AERO AVIATION CONSULTING

Landmark Planning & Design Inc.

NEF25
NEF30
NEF35
NEF40
1995 NEF25
1995 NEF35
City of Winnipeg Limits

1 0.5 0 1 2 3 4 Kilometers

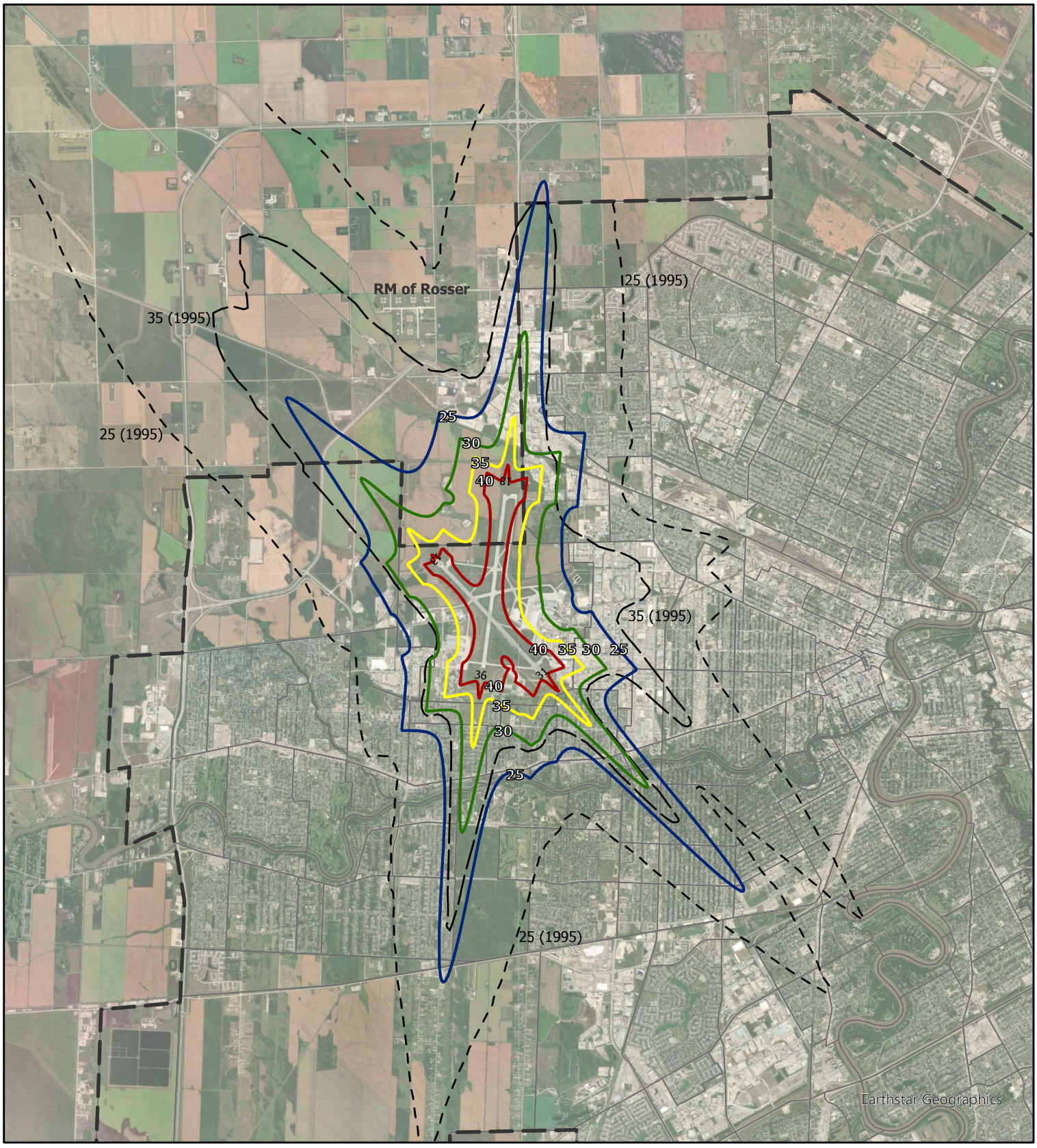
N

5.3 Scenario 3 – 2050 Forecast Conditions

The 95th percentile busy day for 2050 was forecast to consist of 423 total movements, including 26 local movements and 397 itinerant movements. The resulting noise contours for 2050 are presented in Figure 5.3.

Scenario Specific Assumptions

1. As with Scenario 2, the runway utilization percentages used in the preparation of the 2019 contours were assumed to be representative of typical operations.
2. The forecast aircraft movement growth rate was applied to the 2019 95th percentile busy day, resulting in the same proportion of aircraft types, flight paths, ranges, and day/night split as 2019, but with forecast aircraft movements representative of 2050.
3. As with Scenario 2, Scenario 3 does not model the impacts of a new parallel runway or the extension of existing runways.



NOISE EXPOSURE FORECAST STUDY - WINNIPEG INTERNATIONAL AIRPORT

FIGURE 5.3 - 2050 CONTOURS

JULY 2021

HM AERO AVIATION CONSULTING

Landmark Planning & Design Inc.

NEF25
NEF30
NEF35
NEF40
1995 NEF25
1995 NEF35
City of Winnipeg Limits

1 0.5 0 1 2 3 4 Kilometers

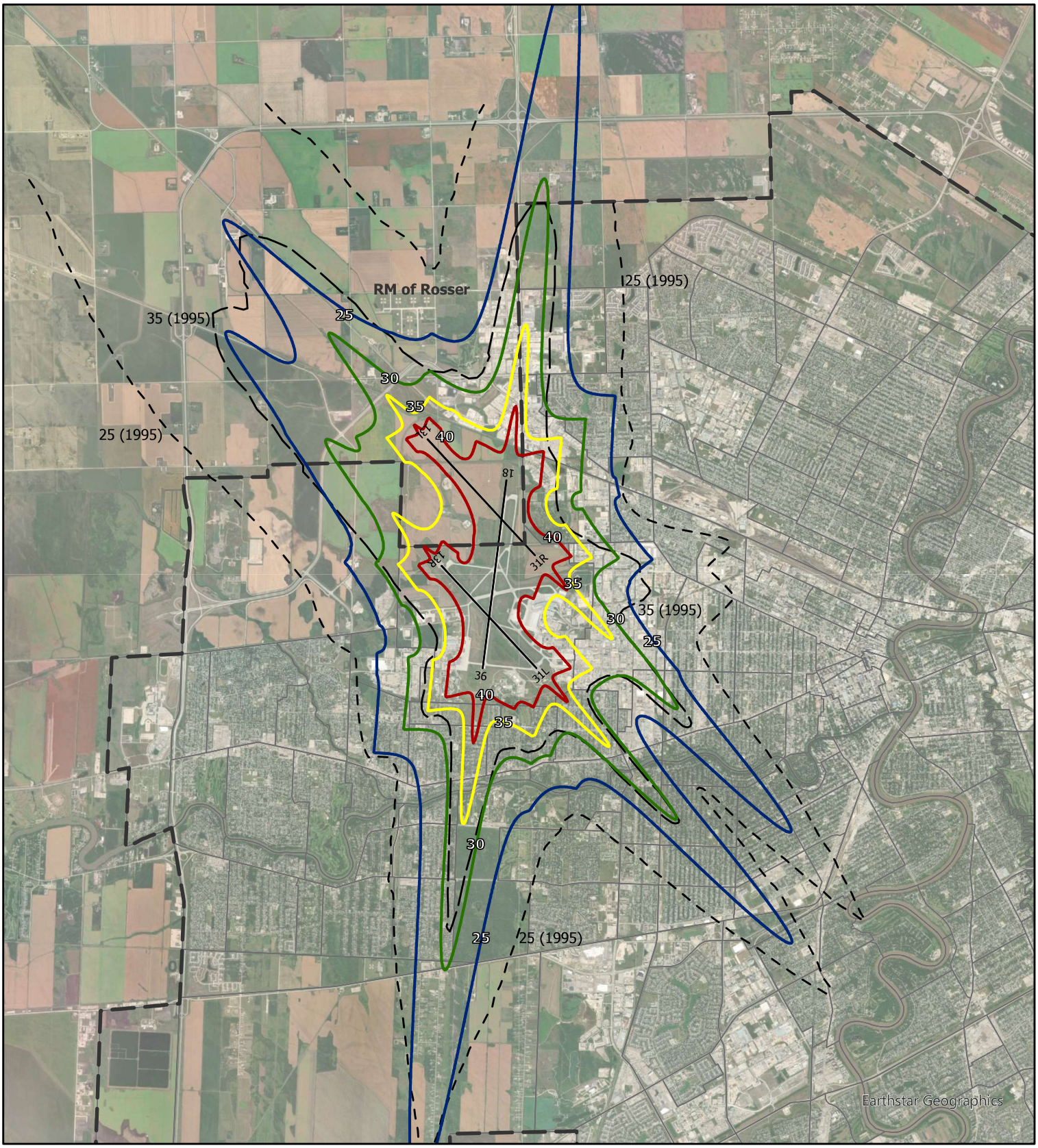
N

5.4 Scenario 4 – Ultimate-Term Conceptual Conditions

The 95th percentile busy day for Scenario 4 – Ultimate-Term Conceptual Conditions includes 77 local movements and 1,168 itinerant movements, for a total of 1,245 movements. The resulting ultimate-term conceptual noise contours are presented as Figure 5.4.

Scenario Specific Assumptions

1. The same proportion of aircraft types, flight paths, ranges, and day/night split as 2019 was applied to develop the ultimate-term contours. Aircraft movements were increased to correspond with the practical runway capacity in a full airfield build-out scenario.
2. A new parallel runway (Runway 13L-31R) is assumed to be in operation and Runway 18-36 will have been extended 1,000 feet (305 metres) to the north based on consultations with WAA.
3. Runway utilization values are as assumed in Section 3.6.1.
4. The location and orientation of the future Runway 13L-31R was informed by the Winnipeg International Airport Zoning Regulations and the 2033 Master Plan. Based on the 'Runway Reserve' illustrated in the 2033 Master Plan, the length of Runway 13L-31R is assumed to be 10,000 ft. (3,048 m).
5. For local aircraft movements, Runways 13L and 31L are assumed to use left-hand traffic patterns. Runways 13R and 31R are assumed to have right-hand traffic patterns.



NOISE EXPOSURE FORECAST STUDY - WINNIPEG INTERNATIONAL AIRPORT

FIGURE 5.4 - ULTIMATE-TERM CONCEPTUAL CONTOURS

JULY 2021

HM AERO AVIATION CONSULTING

Landmark Planning & Design Inc.

NEF25
NEF30
NEF35
NEF40
1995 NEF25
1995 NEF35
City of Winnipeg Limits

1 0.5 0 1 2 3 4 Kilometers

N

6 NEXT STEPS

Following the approval of the Noise Exposure Forecast Study, the project team will complete the Comprehensive Planning Analysis and Recommendations Report. Specifically, the project team will conduct a comprehensive planning analysis with an emphasis on the land use and policy implications of the updated noise contours and the guidelines of TP1247. The project team will provide a set of detailed planning impacts and resulting recommended amendments to municipal and provincial acts, plans, policies, and guidelines.

7 BIBLIOGRAPHY

Airbus. (2019). *Global Market Forecast – Cities, Airports & Aircraft 2019-2018.*

Airport Improvement. (2020, October). *Winnipeg Int'l Adds Multiuse Facility to Enhance Cargo Operations.*

Boeing. (2020). *Commercial Market Outlook: 2020-2039.*

Boeing. (2020). *World Air Cargo Forecast: 2020-2039.*

City of Winnipeg. (1994, May 25). *Airport Vicinity Protection Area Secondary Plan (By-Law No. 6378/94, April 27, 2011 Consolidation Update).*

International Air Transport Association. (2020, July 28). *Recovery Delayed as International Travel Remains Locked Down (Press Release No. 63).*

International Air Transport Association. (2020, November 24). *Outlook for Air Transport and the Airline Industry.*

InterVISTAS Consulting Inc. (n.d.). *2020 Economic Impact Study Final Report: Winnipeg James Armstrong Richardson International Airport (YWG).*

National Airlines Council of Canada. (2020, June 23). *RE: Information Following June 2 Appearance (Correspondence with the Senate Standing Committee on National Finance).*

Transport Canada. (1990, June). *NEF Microcomputer System Users Manual – TP6907E.*

Transport Canada. (2013/14). *TP1247 – Land Use in the Vicinity of Aerodromes (9th Ed.).*

Transport Canada. (2019, September 6). *Government of Canada Invests in Transportation Infrastructure Improvements at the Winnipeg James Armstrong Richardson International Airport.*

Winnipeg Airports Authority. (2000, December). *Winnipeg Airport Development Plan Summary – Bringing 2020 Into Focus.*

Winnipeg Airports Authority. (2015, June 19). *Winnipeg Richardson International Airport – Master Plan 2033.*

Winnipeg Airports Authority. (n.d.). *2019 Annual Report – Leading Transportation Innovation and Growth*.