Chapter 4
Airfield Demand/Capacity Analysis

4.0 BACKGROUND

The purpose of performing a demand/capacity analysis is to compare the capacity of the existing airfield system to forecast operational demand, and to identify if and when capacity improvements may be required during the 20-year planning period. For Smith Reynolds Airport (INT), this was accomplished by comparing the theoretical capacity of the existing airfield system, as determined by the procedures outlined in **FAA Advisory Circular (AC) 150/5060-5**, *Airport Capacity and Delay*, to the *Forecasts of Aviation Demand* in **Chapter 3**. As described throughout this Master Plan Update, the Airport Commission of Forsyth County (ACFC) recognizes the importance of maintaining both Runways 15-33 and Runway 4-22 due in part to the following:

- The primary Runway 15-33 is surrounded on three sides by residential development (to the east, south, and west). In the past, nearby residents have expressed concerns about noise created by the jets that have regularly flown in and out of INT for maintenance.[1] Larger aircraft require the full length of the longer runway; however, smaller, lower flying aircraft have the option of using the smaller crosswind runway (Runway 4-22). Since smaller aircraft comprise a majority of repetitive flight training activity; the availability and utilization of a crosswind runway reduces noise impacts to nearby residential developments.

- "Another common practice is to assign individual primary runways to different airplane classes, such as, separating general aviation from non-general aviation customers, as a means to increase the airport's efficiency."[1] 6,661 jet operations were conducted at INT in 2008, many of which included commercial Boeing 737 jets which regularly visit the airport to undergo maintenance. Because jets fly at faster speeds and produce stronger wake turbulence than pistons, they require greater separations during approach and departure. As such, the ACFC wishes to maintain both runways so that a safe and efficient operating environment can be provided by creating a separation between larger (commercial and corporate) aircraft from smaller general aviation (recreational) aircraft.

Airport capacity is defined by the FAA as an estimate of the number of aircraft that can be processed through the airfield system during a specific period with acceptable levels of delay. As mentioned, airfield capacity was determined for Smith Reynolds Airport according to the procedures outlined in the *Airport Capacity and Delay AC*. This methodology does not account for every possible situation at an airport, but rather the most common situations observed at U.S. airports when the AC was adopted. Further, the *Airport Capacity and Delay AC* provides a

[1] FAA AC 150/5325-4B, Runway Length Requirements for Airport Design, page 3.

methodology for determining the hourly runway capacity, the Annual Service Volume (ASV), and average expected delays. In this chapter, each of these factors was calculated for existing conditions and for every five-year interval of the 20-year planning period. An airport's hourly runway capacity expresses the maximum number of aircraft that can be accommodated under conditions of continuous demand during a one-hour period. It should be noted that the hourly capacity cannot be sustained for long periods or an airport will experience substantial increases in delay. The ASV estimates the annual number of operations that the airfield configuration should be capable of handling with minimal delays. The calculation of ASV considers the fact that a variety of conditions are experienced over a 12-month period, including periods of high and low volumes of activity. The average anticipated delay was based on a ratio of the forecast demand to the calculated ASV. These calculations, using the aforementioned FAA methodology, were based upon the airfield configuration as well as operational and meteorological characteristics, which are described in detail within the following sections.

4.1 AIRSPACE CAPACITY

The Air Traffic Control Tower (ATCT) at Smith Reynolds Airport is open every day from 6:45 a.m. to 9:30 p.m. The ATCT has the responsibility of coordinating aircraft approaches and departures within the airport's Class D airspace. The airport's class D airspace includes the airspace within four nautical miles of INT and extends from the surface to 2,500 feet above ground level (AGL). When the ATCT is closed and when aircraft are flying outside the coverage area, the FAA Terminal Radar Approach Control (TRACON) facility at Piedmont Triad International Airport (GSO) controls IFR traffic flying to and from INT. The main function of a TRACON facility is to control the airspace around airports with high traffic densities, which are typically associated by Class B and C airspaces. The TRACON coverage area includes airspace within a 30 to 50 mile radius up to 10,000 feet, as well as aircraft flying over that airspace.[2]

Discussions with INT's ATCT personnel revealed that there are occasional airspace conflicts between operational activity at INT and nearby GSO. Simultaneous aircraft approaches to Runway 33 at INT and to Runway 5R at GSO create traffic overlap and vertical separation (safety) concerns. It is important to note that GSO recently constructed a new parallel runway (Runway 5L-23R). Because of the new runway's orientation, its construction will not necessarily resolve existing conflicts and may actually cause additional problems in the future. However, ongoing upgrades to the national airspace system (NAS) and other technological developments such as NextGen and the associated satellite-based instrument approaches (e.g., Wide/Local Area Augmentation System), should provide positive contributions to safety and to the local and regional airspace capacity. The forecasted increases in activity levels should have little or no bearing on safety or the airspace capacity of INT.

[2] FAA Fact Sheet, Co-Located TRACONS, March 24, 2006.

4.2 AIRFIELD DEMAND/CAPACITY ANALYSIS

Airfield demand/capacity analyses seek to identify at what point, if any, during the 20-year planning period unacceptable levels of delay may be experienced by airport users, thereby triggering the need for airfield improvements such as additional taxiways, runways, or holding pads. The *Airport Capacity and Delay AC* provides a systematic approach for determining hourly runway and annual airfield capacities (i.e., the ASV), as well as the projected average hourly and annual delays. Each of these was calculated for existing conditions and for every five-year interval of the planning period. The results of the capacity calculations are presented in the following sections.

Hourly Runway Capacity

An airport's hourly runway capacity represents the maximum number of aircraft that can be accommodated under conditions of continuous demand during a one-hour period. It should be noted that typical hourly capacity cannot be sustained over long periods without substantially increasing delay. In evaluating hourly runway capacity, the following factors were considered:

- **Runway Configuration** – The number of runways at an airport and how they are positioned in relation to one another impacts how many arrivals and departures can occur within an hour. For example, if an airport has two runways that are oriented parallel to each other then it is generally possible to have arrivals and departures to both runways at the same time. However, if the two runways intersect, an aircraft departing from one runway must wait for operations on the other to be completed prior to starting its takeoff.

  Smith Reynolds Airport's existing airfield configuration consists of two intersecting runways, Runways 15-33 and 4-22. Both runways can be used simultaneously while land and hold short operations (LAHSO) are in effect. Specifically, LAHSO allows for Runway 33 approaches while operations are simultaneously being conducted on Runway 4-22. During LAHSO, the ATCT instructs pilots to land on Runway 33 and then to hold-short just before the intersection of the two runways until clearance to exit the runway is granted. Unlike a crosswind runway which is needed for weather-related purposes, the use of LAHSO on INT's intersecting runways allows for the simultaneous, but separated, operations by small flight training aircraft and large jets, thus providing enhanced capacity, reduced delays, and a more comfortable operating environment for all pilots.

  Based on discussions with ATCT personnel and a review of historical wind data, it was determined that the majority of INT's operations occur from the south on a northerly heading (i.e., takeoff and landing on Runway 33) or from the west on an easterly heading (i.e., takeoff and landing on Runway 4). This runway use configuration is best represented by **Diagram No. 75** in the *Airport Capacity and Delay AC, Figure 3-2.*

- **Runway Utilization** – The calculation of airfield capacity also considers runway utilization rates for Visual Flight Rules (VFR) and IFR conditions. The runway utilization rates shown in **Table 4-1** were determined through consultation with ATCT personnel and a review of historical wind data. Since these runway utilization rates have the potential to change during the planning period, the airfield capacity calculations should be periodically reviewed for currency.

Table 4-1 Runway Utilization Rates		
Runway End Use	**VFR**	**IFR**
15	15%	22%
33	40%	70%
4	25%	8%
22	20%	0%
Total	100.0%	100.0%

Source: The LPA Group Incorporated, September 2009.

- **Aircraft Mix Index** – In the *Airport Capacity and Delay AC*, the FAA classifies aircraft operations based on their Maximum Takeoff Weight (MTOW). The mix index is a calculated ratio of the aircraft fleet based upon the weight classification system shown in **Table 4-2**. As the number of heavier aircraft increases, so does the mix index. The hourly runway capacity generally decreases as the mix index increases because the FAA requires that heavier aircraft be spaced further apart from other aircraft for safety reasons (e.g., faster air speeds and greater wake turbulence).

  The aircraft mix index is calculated by adding the percent of Class "C" aircraft operations (in terms of total operations) to three times the percent of Class "D" aircraft operations (i.e., **C+3D**). During the planning period at Smith Reynolds Airport, no Class "D" operations are expected, but Class "C" operations are expected to comprise approximately 15 percent of total annual activity each year exclusively on Runway 15-33.

Table 4-2 Aircraft Fleet Mix Classifications				
Aircraft Classification	**Maximum Takeoff Weight (lbs)**	**Number of Engines**	**Wake Turbulence Classification**	**Sample Aircraft**
A	12,500 or less	Single	Small	Cessna 172, Piper PA-28
B	12,500 or less	Multi	Small	Beechcraft King Air, Eclipse 500, Beech Baron
C	12,500-300,000	Multi	Large	Learjet, Gulfstream, Falcon, Boeing 737
D	Over 300,000	Multi	Heavy	B747, L1011, C-135 and C-141

Sources: FAA Advisory Circular 150/5060-5, Airport Capacity and Delay and The LPA Group Incorporated, September 2009.

- **Percentage of Aircraft Arrivals** – An arriving aircraft occupies a runway for a slightly longer period of time as compared to a departing aircraft. As such, the hourly runway capacity decreases as the percentage of aircraft arrivals increases. At INT, the percentage of aircraft arrivals is expected to remain at 50 percent throughout the planning period, or equal to the number of departures.

- **Percentage of Touch-and-Go Operations** – Pilots routinely practice landings and takeoffs by conducting touch-and-go operations, which involves an aircraft landing and then immediately departing without ever coming to a complete stop. This training exercise takes less time to conduct than normal landings where the aircraft departs the runway; therefore, as the number of touch-and-go operations increase, so too does the hourly runway capacity. Touch-and-go operations at INT are typically limited to small piston-powered aircraft. Based on a review of ATCT activity records for local operations, it was determined that touch-and-go operations generally represent 40 to 50 percent of all activity on Runway 4-22 and only a small fraction of Runway 15-33 activity.

- **Meteorological Conditions** – During periods of good visibility, pilots can operate based upon visual observation of other aircraft. As weather conditions deteriorate, (low visibility due to fog, clouds, or precipitation), pilots must rely on instrumentation to operate safely. The *Airport Capacity and Delay AC* considers two operating conditions based upon meteorological conditions – VFR and IFR. During IFR conditions, aircraft are spaced further apart, which lowers the hourly runway capacity. The inventory chapter included an analysis of historical wind data (years 1999 to 2008) from INT's on-site Automated Surface Observing System (ASOS). Since the existing airfield configuration was found to provide more than 95% wind coverage during All Weather, VFR, and IFR conditions, it can be assumed that the airfield configuration and location provide no significant limitations to capacity. Further, according to a review of historical wind data for the years 1999-2008, the airport experiences VFR, IFR, and Closed/Inoperable conditions approximately 88%, 10%, and 2% of the time, respectively.

- **Taxiway Configuration** – The number of taxiways available impacts the hourly runway capacity by influencing when an arriving aircraft will be able to exit the runway after slowing to a safe taxiing speed. The *Airport Capacity and Delay AC* defines optimum ranges for the distance a taxiway should be from the runway arrival end. Based on the methodology in the *Airport Capacity and Delay AC*, only Runway 33 arrivals are provided with enough exit taxiways to achieve the maximum "Exit Factor," which is used to calculate capacity. Therefore, if airfield capacity shortfalls were identified, the airport could benefit from additional exit taxiways. Further, any new development such as a taxiway, hold pad, or apron, may have the potential to improve capacity so long as it does not complicate the airfield configuration.

Considering the various input factors above, the methodology in the *Airport Capacity and Delay AC* was used to calculate the VFR and IFR hourly capacities for Smith Reynolds Airport as shown in **Table 4-3.** Then, based on operating conditions in year 2008, the VFR and IFR hourly capacities were used to calculate the weighted hourly runway capacity throughout the 20-year planning period. The weighted hourly runway capacity takes into account the percent of time each meteorological condition occurs (VFR, IFR, and Closed/Inoperable).

Table 4-3 Calculated Hourly Capacity			
Year	VFR	IFR	Weighted
2008	125	56	113
2013	125	56	113
2018	125	56	113
2023	125	56	113
2028	125	56	113

Source: The LPA Group Incorporated, September 2009.

Theoretical Annual Airfield Capacity

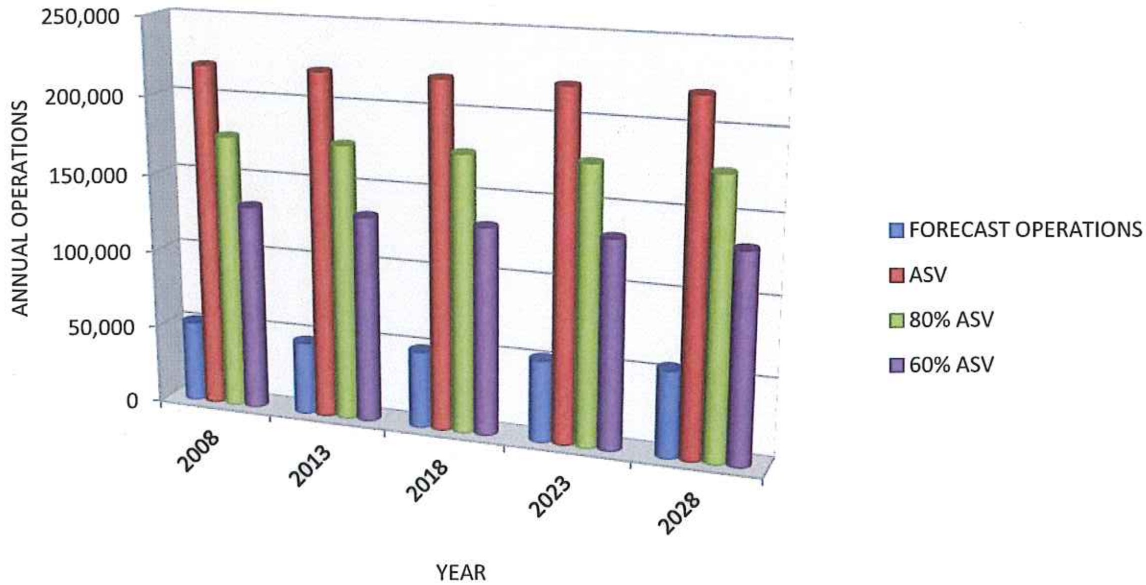
Using the calculated weighted hourly capacity, the *Airport Capacity and Delay AC* provides the methodology for determining the theoretical annual airfield capacity or the ASV. **Table 4-4** presents the results of the ASV calculations throughout the 20-year planning period. It is noted that the ASV is anticipated to remain stable because the mix of aircraft and operational characteristics of the airport are not expected to change drastically over the 20-year planning period.

Additionally, **Table 4-4** and **Exhibit 4-1** show the comparison of projected annual operational demand to theoretical ASV. According to the guidelines in **FAA Order 5090.3B**, *Field Formulation of the National Plan of Integrated Airport Systems*, once the actual demand exceeds 60 percent of the calculated ASV, planning studies should be undertaken to increase airfield capacity, and the construction of capacity improvements should begin once 80 percent of the calculated ASV has been reached. Due to the length of time it may take to implement some airfield improvements, this early planning facilitates the construction of capacity enhancing facilities to meet anticipated demands. As shown, airfield capacity is not expected to reach or exceed the 60 or 80 percent of ASV thresholds through the duration of the planning period.

Table 4-4 Calculated Annual Airfield Capacity			
Year	Annual Operations	ASV	Capacity Level
2008	51,839	210,000	23.56%
2013	46,391	210,000	21.09%
2018	49,036	210,000	22.29%
2023	51,988	210,000	23.63%
2028	55,274	210,000	25.12%

Source: The LPA Group Incorporated, September 2009.

Exhibit 4-1
Calculated Annual Airfield Capacity



Source: The LPA Group Incorporated, September 2009.

Annual Aircraft Delay

The average anticipated delay is based upon a ratio of the forecasted demand to the calculated ASV. In the *Airport Capacity and Delay AC*, the FAA acknowledges that the level of acceptable delay at one airport may differ from the level deemed acceptable at a similar airport. It is important to note that it is not only the delay time that determines acceptability, but also the frequency of delays.

Several methods exist for estimating anticipated delay levels. One method involves using a variety of charts in the *Airport Capacity and Delay AC* to estimate the average delay per aircraft based upon the ratio of annual demand to ASV. This delay per aircraft would then be used to calculate the annual delay for all operations. Another method utilizes software developed by the FAA *(Airport Design Software, Version 4.2d)* to determine the projected delay values. For this study, the anticipated delay values presented in **Table 4-5** were determined using the FAA software. As shown, the average delay per aircraft operation is expected to be minimal at INT throughout the planning period; therefore, the airfield should be able to function with limited congestion, which means that aircraft should be able to arrive and depart the airport with minimal queue times.

Table 4-5 Calculated Annual Airfield Capacity		
Year	Average Delay per Aircraft (Min)	Total Average Annual Delay (Hours)
2008	0.10	86.40
2013	0.10	77.32
2018	0.10	81.73
2023	0.10	86.65
2028	0.10	92.12

Source: The LPA Group Incorporated, September 2009.

Summary of Capacity and Delay

This chapter has indicated that the existing airfield system at Smith Reynolds Airport should be capable of handling projected capacity-related demands without the need for improvements during the 20-year planning period. A summary of these results is presented in **Table 4-6.** However, it should be noted that if activity exceeds forecast levels (such as a change in the aircraft fleet mix, airport's service role, etc.), a need for capacity enhancements such as additional taxiways, hold pads, aprons, etc. may ultimately arise.

Table 4-6 Summary of Airfield Capacity Analysis					
	2008	**2013**	**2018**	**2023**	**2028**
Hourly Capacity					
VFR Capacity Base	125	125	125	125	125
IFR Capacity Base	56	56	56	56	56
Weighted Hourly Capacity	113	113	113	113	113
Annual Airfield Capacity					
Annual Operations	51,839	46,391	49,036	51,988	55,274
ASV	210,000	210,000	210,000	210,000	210,000
%ASV	23.56%	21.09%	22.29%	23.63%	25.12%
Average Minutes of Delay per Aircraft Operation					
Low	0.10	0.10	0.10	0.10	0.10
High	0.10	0.10	0.10	0.10	0.10

Source: The LPA Group Incorporated, September 2009.