Appendix A
Airfield Demand/Capacity Analysis

This white paper document contains the detailed Airfield Demand/Capacity analysis conducted as part of the Asheville Regional Airport Master Plan.

A.1 Airfield Demand/Capacity Analysis

The purpose of the airfield demand/capacity analysis is to assess the capability of the airfield facilities to accommodate projected levels of aircraft operations. The Federal Aviation Administration (FAA) identifies two definitions of airfield capacity in FAA Advisory Circular (AC) 150/5060-5, *Airport Capacity and Delay*. The first definition of airfield capacity pertains to the maximum number of aircraft operations that a specific configuration can accommodate during a specified time interval of continuous demand (i.e. an aircraft is always waiting to depart or land). This level of capacity is influenced by weather conditions, number and configuration of exit taxiways, types of aircraft that use a facility, and air traffic control/airspace handling procedures.

The second definition of airfield capacity is the number of aircraft operations that may occur during a specific time that corresponds with a tolerable aircraft delay. An important difference between these two measures of capacity is that one is defined in terms of delay, while the other is not. Among the reasons to determine delay is that each individual airfield has multiple factors that contribute to its ability to accommodate aircraft. Additionally, the relationship between demand and delay is significantly impacted by patterns of peak demand, which is also unique to an airfield.

The following airfield capacity and delay components are used in this evaluation:

- **Peak hour capacity** – The maximum number of aircraft operations that can occur in one hour under specific operating conditions assuming a continuous demand for service. This is also known as an airfield's maximum hourly throughput capacity.

- **Annual Service Volume (ASV)** – Used by the FAA as an indicator of relative operating capacity. ASV is a reasonable estimate of an airport's annual capacity that accounts for differences in various conditions (i.e. runway use, aircraft mix, weather conditions, etc.) that would be encountered over a year's time. ASV assumes an acceptable level of aircraft delay as described in FAA AC 150/5060-5, *Airport Capacity and Delay*.

- **Average annual delay per operation** – An estimate of the average delay each aircraft operation will experience in a given year. Some operations such as those that occur in peak periods of activity would likely experience longer delays on average while others such as nighttime operations, would likely experience shorter average delays.

A.1.a Factors Affecting Runway Capacity

A number of factors can impact airfield capacity and delay, including:

- Airfield layout and runway configuration
- Number and location of exit taxiways
- Runway use restrictions
- Runway use as dictated by wind conditions
- The percentage of time the airport experiences poor weather conditions
- The level of touch-and-go activity
- Types of aircraft that operate at the airport
- Surrounding terrain/local geography
- Changes in air traffic control procedures

A.1.b Weather Conditions

Weather conditions can impact an airport's capacity by causing conditions that require the facility to close or slow down aircraft operations. There are two categories for weather conditions related to operating aircraft: instrument flight rules (IFR) and visual flight rules (VFR). VFR weather conditions exist when the cloud ceiling is 1,000 feet or greater and visibility is three statute miles or greater. IFR conditions are those below the stated VFR minimums.

It is important to differentiate IFR and VFR conditions because greater separation distances are required under IFR conditions. According to the most recent weather data available through the National Climatic Data Center (NCDC) that is compatible with existing FAA wind analysis software from the Automated Surface Observation System (ASOS) unit located on the Airport observed the following weather conditions for the period from 2000 to 2009:

- 69,638 hourly observations with VFR weather conditions (88.7 percent).
- 8,836 hourly observations with less than VFR weather minimum (11.3 percent) of which:
    - 7,053 hourly observations were with weather conditions below VFR minimums and at or above standard Category I ILS approach minimums of 200 cloud ceiling and 1/2 mile visibility (9.0 percent).

- 1,783 hourly observations of which weather is below standard Category I ILS approach minimums (2.3 percent).

A.1.c Touch and Go Operations

Touch and go operations are defined as those conducted by a single aircraft that lands and departs on a runway without taxiing. Such operations are typically associated with training or recurrence exercises. Typically, airfield capacity increases with the ratio of touch and go operations as aircraft are within the local traffic pattern and available for approaches. ATCT records indicate that local operations account for approximately 20 percent of the total operations, and according to the Asheville ATCT staff, touch and go operations account for approximately 90 percent of local operations. Therefore 18 percent of the total operations are touch and go operations at Asheville Regional Airport.

A.1.d Aircraft Mix Index

The aircraft mix is the relative percentage of operations conducted by four categories of aircraft that operate at an airport. The mix index has a significant impact on airfield capacity. Aircraft are categorized by their physical aspects and their relationship to terms used in wake turbulence standards (see **Table A-1**). It should be important to note that the aircraft categories used in evaluating the aircraft mix index for capacity purposes in FAA AC 150/5060-5, *Airport Capacity and Delay*, varies from the Aircraft Approach Categories (AACs) identified in FAA AC 150/5300-13, *Airport Design*. The primary difference is that the aircraft categories listed below are based on the takeoff weight and wake turbulence factor of an aircraft while the AAC is based upon the approach speed of an aircraft.

Table A-1: Aircraft Categories

Aircraft Category	Take-off Weight (pounds)	Types of Aircraft	Wake Turbulence Factor
A	12,000 or less	Small single engine aircraft	Small
B	12,500 or less	Small multi-engine aircraft	Small
C	12,500 – 300,000	Large aircraft	Large
D	300,000 or more	Heavy aircraft	Heavy

Source: FAA Advisory Circular 150/5060-5, *Airport Capacity and Delay*

The 2010 aircraft mix index has been determined based upon FAA operational data. Airport Traffic Control Tower (ATCT) records obtained through the FAA Air Traffic Activity Data System (ATADS) provides the number of local and itinerant operations. Local operations are assumed to be primarily general aviation and military aircraft that conduct training and touch and go operations. The local general aviation operations are assumed to be nearly all small aircraft in categories A and B. The local military traffic mix is assumed to equal that of itinerant military fleet. For itinerant operations aircraft weight class information was obtained through the FAA's Enhanced Traffic Management System Counts (ETMSC), which provides traffic count information by airport from pilot flight plans and radar track information. **Table A-2** presents the 2010 number of operations by category of aircraft for mix index determination.

Table A-2: Operations by Aircraft Category

Aircraft Category	Itinerant		Local		Total	
	% by Class	Operations	% by Class	Operations	% by Class	Operations
A & B	36.9%	19,537	92.3%	13,348	48.8%	32,884
C	62.8%	33,204	6.9%	998	50.8%	34,204
D	0.3%	139	0.8%	116	0.4%	254
Total		**52,879**		**14,461**		**67,340**

Source: FAA Enhanced Traffic Management System Counts (ETMSC), FAA Air Traffic Activity System (ATADS)

The aircraft mix index in accordance with FAA AC 150/5060-5, *Airport Capacity and Delay*, is the percent of C aircraft plus three times the percent of D aircraft. For VFR weather the total operations by aircraft class have been used. Since very little local activity occurs during IFR weather only the iterant operations have been used in the IFR Mix Index calculation.

- VFR Mix Index = %(C+3D) = %(50.8+3*(0.4)) = 52.0
- IFR Mix Index = %(C+3D) = %(62.8+3*(0.3)) = 63.7

A.1.e Peak Hour Airfield Capacity

Peak hour airfield capacity is defined as the measure of the maximum number of aircraft operations that can be completed on a runway system in one hour. These calculations incorporate runway use configuration, dimensional criteria and spacing, fleet mix, touch and go activity, and runway exit factor. Asheville Regional Airport has a single runway, therefore only a single runway use configuration under VFR and IFR weather conditions was evaluated. The following presents the runway exit information obtained from the ATCT's diagram of intersection distances remaining. It should be noted that intersection distances listed were rounded down to the nearest 50 feet and are not the actual distance from the intersection to the end of the runway. This is done in accordance with air traffic procedures to provide a margin of safety when pilots inquire about intersection distances from air traffic control. For the purposes of the peak hour airfield capacity analysis, these rounded intersection distances were used in the evaluation.

- Runway 16: 300', 1500', 2500', 3700', 4700', 6250', 7700'
- Runway 34: 250', 1700', 3250', 4250, 5450, 6450', 7650'

Utilizing guidelines contained within to FAA AC 150/5060-5, *Airport Capacity and Delay,* hourly capacities for the airfield were computed separately under VFR and IFR conditions. The respective capacities were found to be:

- VFR Capacity = 65 operations
- IFR Capacity = 51 operations

A.1.f Annual Service Volume

Annual Service Volume (ASV) is a reasonable estimate of an airport's annual practical capacity. It accounts for differences in runway use, aircraft mix, weather conditions, pattern of demand (peaking), and other factors that impact an airport. The formula for calculating ASV contains three variables: C_w

(weighted hourly capacity), D (the ratio of annual demand to average daily demand in the peak month), and H (the ratio of average daily demand to average peak hour demand during the peak month). These variables are multiplied to obtain the ASV for the Airport.

Weighted hourly capacity, C_w, has been calculated in accordance with FAA AC 150/5060-5, *Airport Capacity and Delay* as follows:

$$C_w = \frac{(P_1 \times C_1 \times W_1) + (P_2 \times C_2 \times W_2)}{(P_1 \times W_1) + (P_2 \times W_2)} = \frac{(0.887 \times 65 \times 1) + (0.113 \times 51 \times 15)}{(0.887 \times 1) + (0.113 \times 15)} = 55.8$$

P_1, P_2 = Percentage of time runway configuration is used (VFR/IFR)
C_1, C_2 = Capacity under configuration use (VFR/IFR)
W_1, W_2 = ASV weighting factors

The Daily Demand Ratio (D) is the ratio of annual demand to average daily demand in the peak month. Using the data in Chapter 3, *Aviation Forecasts*, this has been calculated as follows:

D = Annual Demand / Peak Month Average Daily Demand
D = 67,340 / 224
D = 300.6

The Hourly Demand Ratio (H) is the ratio of average daily demand to average peak hour demand during the peak month which is 6.65. Using the data in Chapter 3, *Aviation Forecasts*, this has been calculated as follows:

H = Peak Month Average Day Demand / Peak Hour Demand
H = 224 / 31
H = 7.23

Annual Service Volume (ASV) for Asheville Regional Airport is defined as follows:

ASV = C_w* D * H
ASV = 55.8 * 300.6 * 7.23
ASV = 121,272 operations

A single runway with a parallel taxiway can typically accommodate approximately 200,000 annual aircraft operations. The ASV calculated for Asheville Regional Airport is quite a bit below this typical capacity. The lower than typical ASV is primarily being driven by the airport's operational peaking characteristics. The airport has a high percentage of daily activity occurring in the peak hour (13.8 percent was the average peak hour percentage for each day in July 2010), which resulted in a relatively low hourly demand ratio of 7.23. The FAA methodology resulted in a low hourly demand ratio with higher percentages of activity in the peak hour due to the fact that delays increase rapidly as demand nears capacity.

For a mix index of approximately 50 like Asheville's, FAA AC 150/5060-5, *Airport Capacity and Delay* notes that typical hourly demand ratios are between 10 and 13 (between 7.7 percent to 10.0 percent of the daily operations in the peak hour). If Asheville's hourly demand ratio were to increase to the typical averages of 10 to 13, its ASV would increase to between 167,735 and 218,055 annual operations. Therefore while the ASV at Asheville is currently 121,272 operations, there is the potential for changes in the peaking characteristics to alter and actually increase the ASV. The following sections highlight the aircraft delays and results of airfield demand/capacity analysis.

A.1.g Range of Delay

The second factor in determining an airport's practical capacity is to calculate the amount of delay an aircraft may experience at the facility, which is described in minutes per aircraft operation. As was noted earlier, ASV assumes an acceptable level of average aircraft delay. FAA AC 150/5060-5, *Airport Capacity and Delay,* indicates that for air carrier airports this is the level of annual activity at which the average delay per aircraft is between 2.30 and 3.5 minutes. The relationship between the ratio of demand to ASV and delay is shown in **Table A-3**. The chart depicts the average delay per aircraft based upon the ratio of annual demand to annual service volume; FAA guidance notes that the upper part of the band applies to air carrier airports and the full band applies to general aviation airports. The upper part of the band has been used to determine annual average delay per aircraft at the Airport. FAA guidance also notes that individual aircraft delays can be 5 to 10 times the average delay.

Table A-3: Ratio of Demand to ASV and Delay

Ratio of Annual Demand to ASV	Annual Average Aircraft Delay (min)	Peak Delays for Individual Aircraft (min)
0.1	0.05 - 0.05	0.25 - 0.50
0.2	0.10 - 0.15	0.50 - 1.50
0.3	0.20 - 0.25	1.00 - 2.50
0.4	0.25 - 0.30	1.25 - 3.00
0.5	0.35 - 0.50	1.75 - 5.00
0.6	0.50 - 0.75	2.50 - 7.50
0.7	0.65 - 1.05	3.25 - 10.50
0.8	0.95 - 1.45	4.75 - 14.50
0.9	1.40 - 2.15	7.00 - 21.50
1.0	2.30 - 3.50	11.50 - 35.00
1.1	4.40 - 7.00	22.00 - 70.00

Source: FAA AC 150/5060-5, *Airport Capacity and Delay*

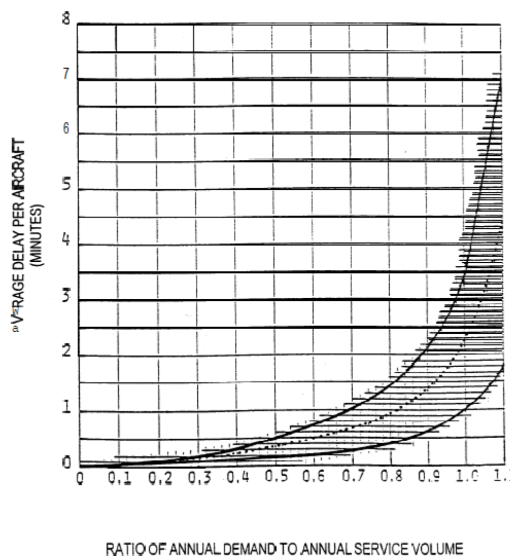

Table A-4 depicts the ratio of annual demand to annual service volume for Asheville Regional Airport and the anticipated range of average and peak aircraft delays. Average delays are anticipated to increase from a range of 0.41 to 0.57 minutes to a range of 0.66 to 0.96 minutes in 2030.

Table A-4: FAA Estimated Delay Ranges

Year	Annual Demand	Ratio of Demand to ASV*	Range of Avg Aircraft Delay (min)	Range of Peak Aircraft Delays (min)
	ASV =	121,272		
Historical:				
2005	70,532	0.58	0.45 - 0.64	2.27 - 6.37
2006	74,373	0.61	0.52 - 0.73	2.58 - 7.31
2007	81,674	0.67	0.66 - 0.95	3.28 - 9.49
2008	76,840	0.63	0.56 - 0.80	2.80 - 7.98
2009	66,437	0.55	0.40 - 0.55	1.98 - 5.51
2010	67,340	0.56	0.41 - 0.57	2.04 - 5.69
Projected:				
2015	70,191	0.58	0.45 - 0.63	2.25 - 6.30
2020	74,025	0.61	0.51 - 0.72	2.55 - 7.22
2025	77,868	0.64	0.58 - 0.83	2.89 - 8.28
2030	82,066	0.68	0.66 - 0.96	3.32 - 9.62

Source: FAA AC 150/5060-5, *Airport Capacity and Delay*

A.1.h Runway Demand/Capacity Summary

FAA Order 5090.3C, *Field Formulation of the National Plan of Integrated Airport Systems (NPIAS)*, notes that capacity improvements should be recommended with sufficient lead-time so that the improvement can be made before the problem becomes critical and delays are excessive. For runway capacity it recommends that capacity development begin when demand reaches 60 percent to 75 percent of annual capacity. As shown in **Table A-4**, at Asheville Regional Airport, demand in 2010 was 56 percent of capacity and demand in 2030 is projected to be 68 percent of capacity. These levels are near the FAA recommended thresholds, but are not anticipated to exceed the 75 percent threshold within the planning period.

Additionally, as was noted earlier, the annual service volume or annual capacity at Asheville Regional Airport is somewhat lower than what is typical for an airport of its type due to the high level of activity occurring in the peak hour(s) each day in the peak months. The high volume of activity in these peak hours is being driven primarily by general aviation activity. During the peak month of July, on average, operations at the airport were 30.4 percent commercial, 62.3 percent general aviation, and 7.3 percent military; however, during peak hours when total operations were more than25 per hour, operations were 20.0 percent commercial, 69.4 percent general aviation, and 10.6 percent military. This indicates that commercial operations are nearly one third of total operations; however, during peak hours commercial operations are only one fifth of operations. It is anticipated that as demand increases and delays increase, the general aviation activity would likely alter its characteristics either by using less busy times of the day for training activity or by transitioning to other surrounding airports for touch and go training activity due to the delays at the Airport.

The amount of daily activity currently occurring in the peak hour, 13.8 percent, has been maintained in the activity projections trough the projected period as a conservative projection; however if the peaking characteristics of the operational demand were to change from 13.8 percent of the daily demand occurring in the peak hour to a more typical 10.0 percent for air carrier airports, the ASV of the airport would increase from 121,272 to 167,735. This would lower the ratio of annual demand to capacity below 50 percent and alleviate any capacity concerns within the planning period. It is also likely that near the end of the projection period as peak hour delays begin to increase, general aviation users will alter their usage characteristics to avoid the delays experienced during these busy or congested periods. Therefore, capacity at the Airport appears adequate for demand projected throughout the planning period.