Chapter 4 – Capacity /Demand Analysis

This section will review the ability of each airport to accommodate the projected activity for each airport during the planning period. This chapter makes use of the operational forecasts represented in Chapter 3 of this CSASP.

When planning the state aviation system for the next twenty years it is important to determine the demand and capacity associated with this system. This demand and capacity relationship identifies a service level for the airports in the system, and the service level needed to be acceptable by both the system users and operators. For operational capacity the level of service provided by an airfield is defined by the amount of aircraft delay encountered. The shorter the delay the higher the level of service. As operational demand at an airport nears 100 percent of capacity, the delay experienced by an aircraft increases and the quality of service declines. For based aircraft the level of service is determined by an airports ability to accommodate based aircraft. The results of the capacity / demand analysis will be used to identify airports that are expected to have substantial increases in based aircraft during the planning period. It will also identify possible airfield improvements that may provide acceptable capacity at airports in Connecticut.

4.1 Calculating Airside Operational Capacity

Airport operational capacity can be measured in operations per hour and annual service volume. The operations per hour are determined based on either Visual Flight Rules (VFR) or Instrument Flight Rules (IFR) conditions. A theoretical maximum number of operations for an airport is determined based on airfield layout and configurations, weather, aircraft fleet mix and touch and go operations. For this CSASP, the capacity will be measured in annual service volume (ASV), as defined by the FAA. It is important to note that this measure is an estimate, applicable for long range planning purposes, which provides a reasonable estimate of the amount of annual operations that can occur at the airport. The estimate for ASV accounts for differences in runway use, aircraft mix, weather conditions, etc., that would be encountered over a years time. It is important to note that an airport can operate at a level above their theoretical ASV. However, ASV provides a good reference point for the general planning of capacity-related improvements. The ASV will identify which airports are approaching or are at their maximum capacity in the year 2004 and in the future year 2025. This is important because, as annual operations approach the ASV of an airport, the aircraft delay will increase rapidly. FAA recommends a detailed analysis of airport capacity should be performed for airports at 60 percent of their capacity and capacity improvements should be in place when an airport reaches 80 percent capacity.

4.1.1 Airfield Layout and Configuration

An airport's runway layout, taxiways, exit ramps, navigational aids and air traffic control tower (ATCT) all effect its ability to accommodate various types of aircraft as well as the number of operations. A description of each of these factors follows.

A. The number of runways and their orientation directly affects the capacity of an airport. For example, an airport with a single runway typically has a lower capacity than an airport with multiple runways. However, two runways that intersect act as a single runway, because only one runway can be active at a time. While this type of configuration cannot have multiple operations occurring simultaneously, it may have slightly greater capacity if the aircraft are controlled efficiently. This can be done by having hold-short procedures in effect for aircraft waiting to takeoff from the airport. One of the most efficient layouts for an airport is one with dual parallel runways. If the runway spacing (centerline to centerline) is adequate, these runways can operate in tandem with each other and dramatically increase the capacity of an airport.

B. The system of taxiways at an airport also plays a large role in how efficient an airport can accommodate aircraft operations. Airports that have parallel taxiways that traverse the length of the runway are more efficient than airports that do not. If there is not a full-length taxiway, an aircraft may have to turn around on the runway and "back taxi" to the nearest exit ramp to access the taxiway before the runway can be cleared for another approaching aircraft. If the airport has full-length taxiways, the aircraft can continue forward to access the taxiway system at the nearest exit ramp. This greatly reduces the amount of time that a runway is occupied and therefore the amount of time that a runway cannot be used.

C. Similar to the effects that the taxiway system has on operational capacity is the number of exit ramps that a runway has. The exit ramps allow aircraft to exit the runway and access the network of taxiways on the airport. More importantly, exit ramps allow the aircraft to "clear" the runway, which allows another operation to occur if needed. If exit ramps are located only at the ends of a runway than an aircraft that lands must "taxi" to the end of the runway before exiting. For smaller aircraft, this can be a substantial distance since they may not use the full runway for landings. Identifying the predominant type of aircraft using an airport can determine the most efficient number of exit ramps. Allowing aircraft to exit the runway as quickly as possible can clear the runway for the next operation and increase the number of operations that can be accommodated.

D. Another item that is considered when determining the ASV of an airport is its navigational aids. Whether or not there is an instrument landing system (ILS) for runway approaches can greatly change the capacity of an airport. Without an ILS, the runway can be "closed" due to weather. If a pilot is flying under visual flight rules (VFR) and visual meteorological conditions (VMC) are not met, they cannot land or depart from that airport. However, at an airport that has an ILS with a published approach, an aircraft could land and depart when VMC conditions are not met. With

an ILS, aircraft have the potential to still operate into and out of the airport when VMC conditions are not met. Without an ILS, the airport could shut down amid the same conditions. Obviously being able to keep an airport open during periods of inclement weather allows more operations to occur and therefore increases the capacity of the airport.

E. For determining ASV, another item reviewed is whether an airport has an aircraft traffic control tower (ATCT). An ATCT improves the efficiency of an airport by coordinating all activities on the runways and taxiways and by controlling the airspace surrounding the airport. By coordinating the movement of aircraft, the ATCT can ensure that the aircraft operators follow the most safe and efficient route to clear the runways and taxiway system, which can increase operational capacity.

4.1.2 Weather

Weather conditions can affect airport operational capacity limiting or temporarily ceasing operations. Meteorological conditions are typically divided into two different categories: visual meteorological condition (VMC) and instrument meteorological conditions (IMC). VMC conditions are weather conditions in which VFR apply; expressed in terms of visibility, ceiling height, and aircraft clearance from clouds along the path of flight. Requirements for VFR are normally 3-mile visibility and a 1000-foot cloud ceiling above the airport, along the flight path. IMC conditions are also expressed in terms of visibility, distance from cloud ceiling, and ceiling. They are less than the minimums specified for visual meteorological conditions. During IMC conditions, fewer operations can occur because greater aircraft spacing is needed for landing and departures. The amount of time that an airport is closed due to weather conditions is determined and factored into calculating the ASV.

Another condition that is considered with regards to weather is the prevailing wind direction. Airports are typically configured so the runway lies in line with the prevailing wind direction. Aircraft generally have to land and takeoff into the wind, therefore having an airports runway aligned with the prevailing wind is an important factor in determining the ASV. If winds are blowing across a runway a pilot must calculate the crosswind and determine if they are still able to land or depart safely. The smaller the aircraft the more susceptible they are to crosswinds during landings and departures. The frequency a runway needs to be closed due to crosswinds affects the volume of operations that can occur at the airport. FAA recommends that an airport's runway configuration provide wind coverage 95 percent of the time. This is why airports with crosswind runways are common, to greatly limit the number of occasions they are shut down due to winds not aligning with a runway.

4.1.3 Aircraft Fleet Mix

Aircraft fleet mix is another important component when determining the capacity of an airport. Fleet mix is the relative percentage of aircraft operations by each of the four classes of aircraft A, B, C, and D. These classes refer to aircraft with the following characteristics; Class A, less than 12,500 lbs single engine; Class B, less than 12,500 lbs multi-engine; Class C, 12,500 to 300,000 lbs multi-engine; and Class D, over 300,000 lbs multi-engine. For capacity purposes, aircraft differ by approach speed and size. The operational capacity of an airport decreases as the fleet mix of an airport increases. In other words, airports that are utilized by similar aircraft have greater operational capacity compared to those with a large variation in the type of aircraft. When aircraft of different sizes and speeds use the same airport, the spacing between the aircraft is increased to account for the different operating characteristics of the aircraft, therefore decreasing capacity. The reason for this increase in spacing is that heavy aircraft create wake turbulence and wing tip vortices that require greater spacing, especially between larger and smaller aircraft. This turbulence and vortices need time to dissipate before the next aircraft utilizes the runway; this is especially true for smaller aircraft. Because of this, the greater the size and speed of aircraft using an airport the greater the spacing that is required, especially if a smaller aircraft is following a larger. Therefore a single runway can process more operations if the fleet mix is consistent.

4.1.4 Touch and Go Operations

A touch and go operation is one in which an aircraft lands and departs on a runway without exiting the traffic pattern or coming to a stop. Each of these landings or departures is considered an operation. Therefore operations of this type can increase the number of operations at an airport because there are always aircraft in the traffic pattern ready for approach to a runway. Therefore at an airport with a large number of touch and go operations, runways rarely sit idle awaiting aircraft to come in for a landing. However, these operations can make it difficult for an aircraft not in the traffic pattern (coming from a different origination) to land at the airport. For example: if the traffic pattern is full with aircraft performing touch and go operations, an aircraft wanting to land at the airport will have to wait for an opening in the traffic pattern before being able to land.

4.2 Capacity for Based Aircraft

The capacity analysis for based aircraft is a less defined process. While airports plan for additional storage for based aircraft, this typically consists of designating a parcel of property for this purpose. Many times a FBO will choose to build apron area for tie downs or T-hangers for their tenants at the airport, relieving the airport from the financial burden of constructing these facilities.

For Connecticut, based aircraft are projected to increase from 1,766 aircraft in year 2003 to 2,069 aircraft in year 2025. While the increase is substantial (303), it typically does not entail a large increase at any single airport. The six State and four Municipally owned airports account for the majority (255) of this projection (Table 4.1). Of these, only five facilities are expected to have an additional 25 or more based aircraft during the analysis period. These include Hartford Brainard, Danielson and Bridgeport-Sikorski airports, with Groton-New London and Waterbury-Oxford airports projected to see an increase of over 40 aircraft.

Table 4.1

Project Increase in Based Aircraft

Airport Name	**Projected Based Aircraft**		**Increase of Based Aircraft**
State Owned Airports	**2003**	**2025**	
Bradley International Airport	83	94	**11**
Groton-New London Airport	51	94	**43**
Hartford-Brainard Airport	185	208	**23**
Waterbury-Oxford Airport	242	287	**45**
Windham Airport	64	85	**21**
Danielson Airport	62	95	**33**
Municipal Airports			
Tweed-New Haven Airport	72	91	**19**
Bridgeport-Sikorski Airport	248	283	**35**
Danbury Municipal Airport	229	245	**16**
Meriden-Markham Airport	78	87	**9**

4.3 Airfield Capacity Adequacy Analysis

4.3.1 Operational Adequacy

For system planning purposes, airfield operational capacity is expressed in an annual measure. The ASV was calculated for each of the airports in Connecticut that are open to the public. These calculations were made using the FAA Advisory Circular150/5060-5, “Airport Capacity and Delay”. Estimates of ASV for each system airport are compared to the year 2004 aircraft operations in Table 4.2. For example if an airport’s ASV is 100,000 operations and the actual operations that occur at the airport are 50,000 then the airport is operating at 50 percent of its annual operating capacity. As can be seen in Table 4.2 the ASV’s for Connecticut airports range from 11,000 operations for Stonington Airpark to 263,000 operations for Bradley International Airport. The ASV numbers were also compared to the 2025 operations estimates for each system airport as can be seen in Table 4.3. This table does not account for potential development

Table 4.2

Airport Capacity - 2004

Airport Name	**Airport Capacity**	**Operations**	**Percent of Capacity**
State Owned Airports			
Bradley International Airport *	263,000	147,500	56%
Groton-New London Airport	230,000	66,200	29%
Hartford-Brainard Airport	230,000	101,000	44%
Waterbury-Oxford Airport **	230,000	65,900	29%
Windham Airport	125,000	33,100	26%
Danielson Airport	107,400	21,700	20%
Total	1,185,400	435,400	37% Avg.
Municipal Airports			
Tweed-New Haven Airport	230,000	64,600	28%
Bridgeport-Sikorski Airport	200,000	80,500	40%
Danbury Municipal Airport**	180,000	87,100	48%
Meriden-Markham Airport	118,100	19,500	17%
Total	728,100	251,700	35% Avg.
Pivately Owned Airports Open For Public Use			
Candlelight Farms	59,600	11,450	19%
Chester Airport	99,000	21,650	22%
Ellington Airport	156,000	30,300	19%
Goodspeed Airport	62,600	7,550	12%
Griswold Airport	34,000	3,250	10%
Robertson Field Airport	148,000	61,600	42%
Salmon River Airfield	37,500	750	2%
Simsbury Airport	64,000	9,850	15%
Skylark Airpark	110,100	17,600	16%
Stonington Airpark	11,000	50	0%
Toutant Airport	28,000	130	0%
Waterbury Airport	37,400	1,050	3%
Woodstock Airport	44,600	100	0%
Total	891,800	165,330	19% Avg.
Mountain Meadow Airport^	49,500	13,100	26%
Statewide Totals	2,805,300	852,430	30% Avg.

* Year 2002

** Year 2003

^ Airport Closed in April, 2004

Table 4.3

Airport Capacity - 2025

Airport Name	**Projected Airport Capacity**	**Operations**	**Percent of Capacity**
State Owned Airports			
Bradley International Airport*	270,000	214,700	80%
Groton-New London Airport	230,000	114,500	50%
Hartford-Brainard Airport	230,000	137,800	60%
Waterbury-Oxford Airport **	230,000	87,000	38%
Windham Airport	125,000	43,700	35%
Danielson Airport	107,400	29,700	28%
Total	1,192,400	627,400	53% Avg.
Municipal Airports			
Tweed-New Haven Airport	230,000	93,600	41%
Bridgeport-Sikorski Airport	200,000	109,300	55%
Danbury Municipal Airport	180,000	145,700	81%
Meriden-Markham Airport	118,100	29,500	25%
Total	728,100	378,100	52% Avg.
Pivately Owned Airports Open For Public Use			
Candlelight Farms	59,600	14,100	24%
Chester Airport	99,000	26,700	27%
Ellington Airport	156,000	37,300	24%
Goodspeed Airport	62,600	9,300	15%
Griswold Airport	34,000	4,050	12%
Robertson Field Airport	148,000	75,900	51%
Salmon River Airfield	37,500	950	3%
Simsbury Airport	64,000	12,150	19%
Skylark Airpark	110,100	21,650	20%
Stonington Airpark	11,000	50	0%
Toutant Airport	28,000	130	0%
Waterbury Airport	37,400	1,250	3%
Woodstock Airport	44,600	100	0%
Total	891,800	203,630	23% Avg.
Mountain Meadow Airport^	0	0	0%
Statewide Totals	2,812,300	1,209,130	43% Avg.

* Year 2022

** Year 2023

^ Airport Closed in April, 2004

projects, other than those discussed in Chapter 3, which may increase operational capacity. These data allow for the comparison of how well the system will be able to handle the projected future operations.

The FAA recommends that planning for additional operational capacity begin when actual annual operations reach 60 percent of capacity. When operational capacity reaches 80 percent, projects to increase and enhance the operational capacity should be identified and implemented. For system planning purposes, airports that are over 50 percent will be reviewed to determine if they will meet their capacity limits. In the year 2004, only Bradley International Airport was above 50 percent capacity at 56 percent; while Hartford Brainard at 44 percent; and Danbury Municipal at 48 percent were approaching 50 percent. In year 2025, two additional airports are projected to be near or above the 50 percent, Groton-New London at 50 percent and Bridgeport-Sikorsky at 55 percent.

In the base year (2004) there were no system airports that exceeded or were approaching 80 percent capacity. The highest for the year 2004, as can be seen in Table 4.4, is 56 percent for Bradley International Airport. However, in 2025 BDL and DXR are expected to reach 80 percent capacity. Since BDL and DXR are presently approaching 60 percent capacity, studies to manage this issue should be planned or in progress. In addition, because these airports are projected to be operating at close to capacity in 2025, projects will need to be implemented to address this situation.

Table 4.4

Airports Exceeding 50 Percent Capacity

		Percent Capacity	
	ASV	2004	2025
Bradley International	263,000*	56%	80%
Groton-New London	230,000	29%	50%
Hartford-Brainard	230,000	44%	60%
Bridgeport-Sikorski	200,000	40%	55%
Danbury Municipal	180,000	48%	81%

* BDL's ASV in 2025 is 270,000 due to ongoing projects

Determining the capacities of the system airports is a critical part of this CSASP; because as can be seen in Table 4.5 the Average Aircraft Delay increases significantly as an airport approaches operating at its capacity. This table represents the average delay for airports by comparing the annual demand versus the annual service volume. The numbers shown are an average, which accounts for most general aviation airports. Airports that are dominated by commercial air service tend to have higher delays per aircraft, while small general aviation airports will usually have less delay.

Table 4.5	
Average Aircraft Delay	
Ratio of Annual Demand to ASV	Average Aircraft Delay in Minutes
0.1	0.0
0.2	0.1
0.3	0.2
0.4	0.3
0.5	0.4
0.6	0.5
0.7	0.7
0.8	0.9
0.9	1.4
1.0	2.3
1.1	4.4

Source: FAA Advisory Circular 150/5060-5 Change 2, Figure 2-2.
Average aircraft delay for long range planning

For this reason, it is critical to ensure that the FAA's criteria is used, so that planning can begin early (at 60 percent capacity) and projects can be implemented (by 80 percent capacity), to keep delays to a minimum.

4.3.2 Based Aircraft Adequacy

As with operational capacity, the projected number of based aircraft has been reviewed to determine if an airport can account for these in the future. This CSASP projects an increase of 303 aircraft in Connecticut by the year 2025. Airport master plans account for an increase in based aircraft and typically designate a section of airport property that can be developed into aircraft tie-downs or T-hangers. This allows for expansion of existing aircraft storage facilities if required in the future. Most system airports are expected to experience only a small increase in based aircraft and not have difficulty meeting the expansion needs projected for the study period. However, Groton-New London, Waterbury-Oxford, Bridgeport-Sikorsky and Danielson airports should each plan for specific ways to account for the projected increase. The normal process for this to be done is in an airport master plan update. Waterbury-Oxford and Danielson are preparing airport master plan updates and Bridgeport (1995) will likely be updating its master plan in the near future. Groton-New London completed an airport master plan update in 1999, which found that there was a surplus of area for based aircraft at the airport. As part of future master plans, more detailed aircraft forecasts should be prepared and facilities to accommodate increases in the based aircraft should be considered in future planning efforts.

4.4 Operational Capacity Enhancement Strategies

While later sections of this CSASP will make further recommendations for the system airports, there are generic strategies that can be implemented to improve capacity at airports in general. Capacity improvements fall into two major categories, new or upgraded facilities and demand management strategies. A brief overview of these strategies is discussed below.

4.4.1 Airside Facilities

There are a number of airport facility improvements that can be implemented to enhance capacity. However, each airport must be reviewed to identify cost-effective modifications that will improve capacity without compromising safety. Modifying existing or constructing new taxiways, exit ramps or NAVAIDS and improving approaches can enhance the capacity at an airport. If all of the facility improvements have been constructed to improve capacity as discussed above, another option, which many commercial airports have used to increase capacity, is a parallel runway. If an airport already has full parallel taxiways, adequate exit ramps, ATCT, lighting and proper instrumentation, a new parallel runway, with adequate spacing, can increase capacity by up to 50 percent. Unfortunately, this option is rarely feasible due to available land, environmental controls, and associated costs. These controls dictate whether a new runway can and will be constructed regardless of airport capacity problems. It should be stressed that while these strategies can increase capacity each airport should be analyzed to determine what improvements could best accomplish the operating goal.

4.4.2 Demand Management

Because some of the improvements stated earlier, could either take an extensive amount of time to implement or may not be desirable due to other controls, demand management is another alternative to address capacity needs. Such strategies can reduce the number of operations occurring at airports. Similar to facility development, demand management strategies must be tailored to the individual airport. Two general categories of demand management that may be considered are off-airport facilities and changes in operational procedures.

A. Off Airport Facilities

For commercial airports, a reliever airport can take a large portion of the general aviation aircraft operations away from the airport. If a general aviation airport in close proximity to a commercial airport has the appropriate facilities, it can draw a significant amount of operations from an airport with capacity constraints. General aviation pilots tend to choose airports that are less congested and one

with aircraft types that are similar to theirs. Commercial airports have an aircraft mix (larger aircraft) that make it more difficult for small aircraft operators to enter the traffic pattern and use the airport. A good example of this in Connecticut is Bradley International and Hartford-Brainard Airports. Hartford-Brainard offers adequate facilities for aircraft destined for the central Connecticut area and provides a state of the art airport for general aviation users. This in turn relieves Bradley International Airport of many of these general aviation operations, as well as the training activity that commercial airports try to avoid. While there will always be a segment of the general aviation market wishing to use commercial airports, they tend to be higher end business aircraft which have higher performance characteristics and mesh better with the commercial air traffic.

B. Changes in Operating Procedures

Changes in operating procedures can enhance capacity by creating a more efficiently operating airport. One of these procedures is to shift demand from busy times. For example, airports can attempt to shift demand away from busy times at the airport by limiting training activities at those times. By limiting touch and go flights (training activities) an airport can take aircraft out of the traffic pattern and open it up for itinerant aircraft, thus improving capacity. Another option for towered airports with crosswind runways, are hold short procedures. A hold short procedure would allow an aircraft to taxi to a runway and "hold short" for another aircraft either landing or departing the crosswind runway. Once this plane has either landed or departed, the aircraft "holding short" can depart the airport. This will save time because an aircraft does not have to wait on an apron area until the runway is clear then taxi to the runway to depart. Any procedures that might be implemented would need to be reviewed to ensure that they do not compromise airport safety.

4.5 Summary

One system plan airport was operating near 60 percent of its operational capacity in the year 2004, Bradley International Airport. Another two are expected to reach or exceed 60 percent of their operational capacity in the year 2025: Hartford Brainard and Danbury Municipal Airports. BDL and Danbury Municipal are expected to approach 80 percent of their operational capacity in 2025. FAA recommends that planning for operational capacity enhancement be started when an airport reaches 60 percent of its capacity and that projects be implemented to relieve congestion when they reach 80 percent capacity. None of the privately owned airports are projected to have an issue with operational capacity in the study timeframe. Robertson Field is expected to operate at the greatest operational capacity at 51 percent in 2025, with the other privately owned airports expected to be below this percentage.

While BDL and Danbury Municipal are expected to reach 80 percent operational capacity in the study timeframe; Connecticut system airports overall do not have an operational capacity issue. However, Bradley International and Danbury Municipal Airport should begin assessing the need and desire to enhance the operational capacity at their airports to the extent possible. Bradley International is in the process of updating their master plan and will investigate strategies for improving operational capacity in this process. Danbury Municipal Airport's master plan was last updated in 1996 and will likely be updated in the near future.

For the based aircraft projected for the year 2025, four airports are projected to have a substantial increase. These are Groton-New London, Waterbury-Oxford, Bridgeport-Sikorsky and Danielson. These four airports account for approximately half of the projected growth in based aircraft at system airports. Other system airports are projected to see increases in based aircraft, in the study timeframe, but not as extensive as these four. The State and Municipal airports are projected to account for the majority of the additional based aircraft, while the privately owned airports are projected to only see minor increases. Planning should be undertaken as part of upcoming master plans at these airports to address the needs of based aircraft at the airports.