Facility Requirements

Grand Canyon National Park Airport
Master Plan Update

Chapter 4- Facility Requirements

The Facility Requirements chapter identifies the long-range airfield *and* terminal area facilities needed to satisfy the 20-year forecast of aviation demand at the Grand Canyon National Park Airport (GCN). Airport facilities have been identified based on the accumulation of inventory information and forecast demand elements, and planned in accordance with FAA airport design standards and airspace criteria. It should be noted that the identification of needed facilities does not constitute a *requirement*, but rather an *option* for facility improvements to resolve facility, operational or safety inadequacies, or to make improvements to the airside or landside components as aviation demand warrants.

Airfield, or airside, facility components include runways, taxiways, navigational aids, airfield marking/ signage and lighting. Terminal area, or landside, facility components are comprised of hangars, passenger terminal building, aircraft apron area, ARFF facilities, fuel storage facilities, public auto parking, as well as airport vehicular access and circulation.

Airport Peaking Characteristics

Forecasts of aviation demand, as determined in the previous chapter, are reflective of overall operational growth characteristics of an airport as influenced by global, regional, and local economic parameters, primarily tourism, at GCN. As the need for aviation services increases, so, too, does the demand for individual facilities to accommodate peak periods of aviation activity. Peak traffic demands vary based on monthly, daily and hourly basis and are paramount in planning for developing future airport facilities so that the maximum utilization of the facilities is realized. The overall objective in determining peak periods of aviation activity at GCN is to arrive at a reasonable projection of aviation demand so that ultimate facilities at the airport are not underutilized nor are they inefficient in accommodating forecast aircraft and passenger activity.

Once peaking characteristics for GCN have been established, they will be utilized to evaluate the capability of existing facilities to accommodate future demand projections. By evaluating and identifying deficiencies in the current facilities' ability to meet anticipated aviation demand future facility requirements, or needs, can be established and planned for accordingly.

In determining airport peaking characteristics for GCN, commercial service and general aviation peaking characteristics will be evaluated exclusive of one another. Furthermore, peaking characteristics including peak month, peak day, peak hour operations and enplanements and busy day for each facet of aviation and aircraft activity will be analyzed.

Commercial Service Operational Peaking Characteristics

Peak Month/ Average Day (PMAD) Demand Forecasts

In determining the current and future commercial service peaking characteristics or Peak Month/ Average Day (PMAD) activity at GCN, an annual operational activity analysis to determine the number of operations by month was conducted for the historical years 1990

to 2002. The peak month of activity throughout the past 12 years was the month of August yielding an average operational tempo of approximately 22,000 operations by commercial service aircraft. Furthermore, this relationship accounted for approximately 13 percent of the operational activity, on average, occurring in the month of August. The ratio of activity occurring during the peak month was multiplied by the current and projected operational estimates resulting in a peak month demand forecast throughout the 20 year planning period. The design day demand of the peak month was then determined by multiplying the peak month demand by the number of days in the month of August (31).

A PMAD for GCN was projected for fixed wing and rotorwing aircraft. The rationale behind this decision is because the two aircraft categories have vastly different operational characteristics and procedures at the airport. Fixed wing aircraft at GCN operate exclusively to and from Runway 3-21 and rely heavily on airside components and facilities for safe and efficient operation. Rotorwing aircraft, on the other hand, operate to and from privately owned and operated passenger and helipad facilities apart from the airside environment requiring less dependence on the airfield facilities other than air traffic control (ATC) service at GCN. In essence, fixed wing aircraft determine the necessary airside facility needs to address future capacity and operational issues at GCN based on flight characteristics, whereas rotorwing aircraft will primarily affect the overall airspace capacity and capabilities of the GCN ATC Tower. Table 4.1 on the following page details the PMAD for fixed wing and rotorwing category of aircraft while at the same time depicting the overall PMAD for GCN based on all commercial service aircraft operational activity at the Airport throughout the planning period.

Peak Hourly Demand Forecasts

Peak hour demand forecasts for GCN were derived from the PMAD forecasts, as well as an analysis of historical operational peaking factors. Peak hour operations for GCN were determined by total aircraft operations occurring during the peak day of the month. Given historical data regarding monthly and daily operations at GCN, as well as operational information derived from the PMAD, it was assumed that the peak hour operational activity at GCN is approximately 13 percent of the total daily operations over a span of 12 hours. This ratio of operational activity was applied to the projected operational activity throughout the planning period yielding a peak hourly operational forecast. Table 4.1 details the peak hour operational demand for commercial service fixed wing and rotorwing category of aircraft at GCN throughout the planning period.

General Aviation Operational Peaking Characteristics

Peak general aviation (GA) operational activity occurs during the same period of time as commercial service activity which is during the month of August. Unlike commercial service data that was gathered on operations, GA operational activity information is minimal. However, data collected from the GCN ATCT still allows PMAD and peak hourly activity analysis to be performed for GA operations. The methods and calculations utilized to determine GA peaking characteristics were the same as those utilized for commercial service peaking forecasts.

Table 4.1
Commercial Service Operational Peaking Characteristics
Grand Canyon National Park Airport

	Existing	2007	2012	2017	2022
Fixed Wing Commercial Service Aircraft Peaking Activity					
Annual Operations	43,600	87,700	89,800	96,800	108,600
Peak Month	5,862	11,792	12,074	13,016	14,602
Design Day	189	380	389	420	471
Peak/ Design Hour	25	51	52	56	63
Rotorwing Commercial Service Aircraft Peaking Activity					
Annual Operations	51,200	66,400	68,200	72,000	73,800
Peak Month	6,884	8,928	9,170	9,681	9,923
Design Day	222	288	269	312	320
Peak/ Design Hour	30	39	40	42	43
Fixed Wing + Rotorwing Commercial Service Aircraft Peaking Activity Summary					
Annual Operations	94,800	154,100	158,000	168,800	182,400
Peak Month	12,747	20,720	21,244	22,697	24,525
Design Day	411	668	685	732	791
Peak/ Design Hour	55	90	92	98	106

Source: Commercial Service Operational Peaking Characteristics, December 2003.

Table 4.2 details the peak hour operational demand for GA aircraft activity at GCN throughout the planning period.

Table 4.2
General Aviation Operational Peaking Characteristics
Grand Canyon National Park Airport

	Existing	2007	2012	2017	2022
Forecast of General Aviation Operational Peak Activity (Local + Itinerant)					
Annual Operations	5,350	6,700	8,200	9,600	12,000
Peak Month	719	901	1,103	1,291	1,614
Design Day	23	29	36	42	52
Peak/ Design Hour	3	4	5	5	7

Source: General Aviation Operational Peaking Characteristics, December 2003.

Commercial Service Passenger Peaking Characteristics

Peak Month/ Average Day (PMAD) Passenger Demand Forecasts

In determining the current and future commercial service passenger peaking characteristics or Peak Month/ Average Day (PMAD) passenger activity at GCN, an annual passenger activity analysis to determine the number of operations by month was conducted for the historical years 1999 to 2003. This method is similar to the analysis for commercial operational peak activity. As with operational activity, the peak month of activity throughout the past five (5) years was the month of August yielding an average passenger enplanement figure of approximately 56,800 enplanements by the commercial service fleet, including rotorwing aircraft. This relationship accounted for approximately 12.6 percent of the enplanements, on average, occurring again during the month of

August. The ratio of enplanement activity occurring during the peak month was multiplied by the current and projected operational estimates. This resulted in a peak month enplanement demand forecast throughout the 20 year planning period. The design day passenger demand of the peak month was then determined by multiplying the peak month demand by the number of days in the month of August (31).

A PMAD for GCN passenger enplanements was projected for fixed wing and rotorwing aircraft. Unlike operational peaking characteristics that concentrate in or mainly affect the airside component of the airport, peak passenger enplanement demand primarily affects the landside component of GCN. These include passenger terminal building space requirements and public auto parking needs. Enplanements at the airport resulting from fixed wing aircraft operations will dictate the space requirements necessary for a future passenger terminal building to accommodate ultimate passenger demand. Rotorwing enplanements, on the other hand, will not impact the terminal area in such a dramatic way due to the location of helicopter air tour companies and their accompanying helipads being concentrated outside of the immediate GCN airport terminal complex. In this instance, rotorwing enplanement peak activity projections will dictate the space requirements for private air tour operators to continue to plan for increased demand for rotorwing air tour services. Additionally, the peak enplanement demand for rotorwing aircraft at GCN are an important planning tool for ADOT and will assist the airport sponsor in continuing to recognize the importance and breadth of helicopter air tour activity at GCN.
Table 4.3 details the PMAD passenger enplanement demand projections for fixed wing and rotorwing commercial service aircraft at GCN throughout the planning period.

Peak Hourly Passenger Forecasts
Peak hour passenger demand estimates for GCN were derived from the forecasts, as well as an analysis of historical enplanement peaking factors for the historical years 1999-2003. Peak hour passenger enplanements for GCN were determined by total aircraft operations occurring during the peak day of the month. Taking into account historical data regarding monthly and daily enplanements at GCN, as well as passenger enplanement activity derived from the PMAD, a peaking factor of 0.1269 was applied to the projected passenger activity throughout the planning period yielding a peak hourly enplanement demand for GCN. Table 4.3 details the peak hour passenger demand generated by commercial service fixed wing and rotorwing category of aircraft at GCN throughout the planning period.

Table 4.3
Commercial Service Passenger Peaking Characteristics
Grand Canyon National Park Airport

	Existing	2007	2012	2017	2022
Fixed Wing Commercial Service Passenger Peaking Activity					
Annual Enplanements	224,700	422,100	451,600	486,000	536,500
Peak Month	28,512	53,560	57,303	61,668	68,076
Design Day	920	1,728	1,848	1,989	2,196
Peak/ Design Hour	117	219	235	252	279
Rotorwing Commercial Service Passenger Peaking Activity					
Annual Enplanements	106,300	151,100	155,100	163,600	175,400
Peak Month	13,488	19,173	19,681	20,759	22,256
Design Day	435	618	635	670	718
Peak/ Design Hour	55	78	81	85	91
Fixed Wing + Rotorwing Commercial Service Passenger Peaking Activity Summary					
Annual Enplanements	331,000	573,200	606,700	649,600	711,900
Peak Month	42,001	72,733	76,984	82,428	90,333
Design Day	1,355	2,346	2,483	2,659	2,914
Peak/ Design Hour	172	298	315	337	370

Source: Commercial Service Enplanement Peaking Characteristics, December 2003.

General Aviation Passenger Peaking Characteristics

Given the fact that an overwhelming majority of the passenger enplanements occurring at GCN are generated by commercial service aircraft coupled with the lack of substantial general aviation operational or enplanement activity at GCN, it is assumed that 100 percent of the passenger enplanements taking place at the airport are a result of commercial air tour operational activity. Therefore, PMAD and peak hourly passenger demand projections were not performed for the general aviation facet of flight and passenger activity at GCN.

Airport Demand Capacity

The ability of an airport to accommodate projected aircraft and passenger activity is dependent on three factors: capacity, delay, and demand. Capacity is defined as the ability of a system, which in this case is GCN, to accommodate a given volume of activity or traffic, defined as demand, in a given period of time. For purposes of airport planning, capacity (throughput capacity) is a measure of the maximum number of aircraft operations that can be accommodated on an airport or airport component in one hour. Delay results when the demand for a system (GCN) exceeds the ability, or capacity, of the airport to handle the demand. Lastly, demand, similar to capacity, is the magnitude of aircraft operations to be accommodated by an airport in a specific period of time. This section of the Facility Requirements chapter will analyze all three factors to determine the demand capacity of the Grand Canyon National Park Airport.

The Grand Canyon National Park Airport is divided into two main components which includes the airside or airfield operations area, as well as the landside or terminal area

complex. The demand/ capacity analysis can be viewed as a measure of the ability of the airside component to accommodate future demand, while the ability of the terminal area complex is mainly determined by the Facility Requirements section. The facility requirements analysis will determine the existing adequacy of each component of the airport, as well as the need to develop additional facilities to accommodate 20 year demand estimates.

Airfield Capacity Analysis

The airfield capacity analysis for the Grand Canyon National Park Airport was conducted in accordance with methodologies prescribed within FAA Advisory Circular (AC) 150/ 5060-5, *Airport Capacity and Delay*. In determining the capacity analysis for GCN, factors such as meteorological conditions, runway use percentages, aircraft mix and classifications, percentage of aircraft arrivals, percentage of touch and gos and taxiway locations were analyzed in order to arrive at an Annual Service Volume (ASV), and determine overall hourly capacity. This in turn is used to predict hourly and annual delay at the airport.

Meteorological Conditions

Local climatic characteristics and meteorological conditions have a significant impact on an airport's capability to accommodate demand during periods of inclement weather occurrences. Additionally, runway usage and ATC operational capabilities are also affected which, in turn, directly impacts airport capacity. As such, historic weather characteristics were analyzed to assess the frequency, nature, and duration of meteorological conditions which influence airport use and operational procedures at the Grand Canyon National Park Airport.

Weather conditions that primarily affect operational capacity at airports include wind direction and velocity during Visual Meteorological Conditions (VMC/ VFR) (cloud ceilings $\leq$ 1,000 feet and visibilities $\leq$ three (3) miles), as well as Instrument Meteorological Conditions (IMC/ IFR) (cloud ceilings $\geq$ 1,000 feet and visibilities $\geq$ three (3) miles), cloud ceilings, minimum visibilities and assorted types of precipitation. Chapter II, *Airport Inventory, Climatic Characteristics,* highlighted the weather conditions within the vicinity of GCN. In particular, the South Rim region of the Grand Canyon experiences VMC conditions approximately 345 days per year (94.5 percent of the time), while IMC conditions occurred approximately 20 days per year (5.5 percent of the time). Table 4.4 highlights VMC and IMC weather conditions and percentage of occurrence for each condition throughout the year at GCN.

Runway Use Percentages

Meteorological conditions impact runway use particularly during periods of IMC and inclement weather conditions. The higher percentage of IMC weather occurrences directly results in decreased capacity translating into fewer aircraft operations that can be accommodated at the airport. Wind direction and velocity must also be taken into account due to the fact that these factors dictate runway end usage.

Table 4.4
VMC/ IMC Weather Conditions and Percentage of Occurrence
Grand Canyon National Park Airport

Weather Condition	Description	Percentage of Occurrence	Days per Year
VMC/ VFR	Ceilings ≤ 1,000 feet; visibilities ≤ three (3) mile	94.5%	345
IMC/ IFR	Ceilings ≥ 1,000 feet; visibilities ≥ three (3) miles	2.9%	11
CAT I	Ceilings > 400 and/ or visibilities > one (1) mile; but Ceiling ≤ 200 feet and visibility ≤ ½-mile	1.7%	6
Below Minimums	Ceiling ≥ 200 feet and visibility ≥ ½-mile	0.9%	3

Source: VMC/ IMC Meteorological Conditions Assessment, January 2004.

The GCN Air Traffic Control Tower (ATCT) was surveyed to determine runway use percentages particular to GCN, as well as what runway ends were utilized during IMC and inclement weather conditions. ATC personnel indicated that the approximate percentage of use of Runway 21 by aircraft was 65 percent while the remaining 35 percent of aircraft arrivals were performed on Runway 3. Additionally, 100 percent of IMC arrivals at GCN were conducted to the Runway 3 end due because a published instrument approach does not exist for Runway 21.

Table 4.5 illustrates the runway end utilization during varying weather and climatic conditions at GCN. Results presented in Table 4.5 are based on one calendar year (365 days) in which approximately 1 percent of the time the airport is below required cloud ceiling height and visibility minimums for instrument approach operations and, in essence, is closed to aircraft arrivals.

Table 4.5
Runway End Utilization During Varying Weather Conditions
Grand Canyon National Park Airport

	Weather Conditions		
Runway End	VMC/ VFR	IMC/ IFR	CAT I
3	33.1%	2.8%	1.8%
21	61.4%	0%	0%
Runway End Use (99.1% Total Utilization)	94.5%	2.8%	1.8%

Source: Runway Utilization Assessment, January 2004.

Aircraft Mix

Aircraft mix is the relative percentage of operations conducted by a particular class of aircraft based on specific physical aspects. For purposes of capacity analysis, aircraft mix classifies aircraft according to their wake turbulence characteristics. Also included in the classification is maximum certified takeoff weight (MTOW) and number of engines. This classification differs from aircraft fleet mix utilized to define an Airport Reference Code (ARC) referenced within FAA AC 150/ 5300-13, *Airport Design.* The following table of information presents the wake turbulence classifications utilized to define the aircraft mix for airfield capacity calculation as referenced in AC 150/ 5060-5, *Airport Capacity and Delay*.

Aircraft Mix Classifications

Aircraft Class	Max. Cert. Takeoff Weight (MTOW)	Number of Engines	Wake Turbulence Classification
A	12,500 lbs. or less	Single	Small (S)
B		Multi	
C	12,500- 300,000 lbs.	Multi	Large (L)
D	Over 300,000 lbs.	Multi	Heavy (H)

Source: AC 150/ 5060-5, *Airport Capacity and Delay,* Change 2, 1995.

During the completion of Chapter III, *Aviation Demand Forecasts,* a commercial service aircraft fleet mix was determined by summarizing the total number of aircraft conducting commercial service operations at GCN. This analysis included a breakdown of the commercial service fleet mix by aircraft category and included the projection of rotorwing aircraft. For purposes of determining fixed wing airfield capacity and aircraft mix, rotorwing aircraft will be excluded from the mix classification forecast, thereby reducing the number of the forecasted commercial service fleet to 57 total aircraft.

Table 4.6 presents the forecast aircraft mix by aircraft and wake turbulence classification at the Grand Canyon National Park Airport. The information presented in Table 4.6 indicates that aircraft class D (over 300,000 pounds) was not projected to contribute regular operational activity at GCN as part of the overall commercial service fleet mix at the airport.

Table 4.6
Summary of Aircraft Mix Classification Forecast
Grand Canyon National Park Airport

	Aircraft Wake Turbulence Classification by Percentage of Use					
	A	B	C			D
Forecast Year	Single Engine	Multi-Engine	Turbo-Prop (15 Seats)	Turbo-Prop (19 Seats)	Turbine/ Jet	Turbine/ Jet (Over 300,000 lbs.)
Existing	4.2%	2.1%	19.1%	72.3%	2.1%	0.0%
2007	6.2%	2.0%	18.7%	70.8%	2.0%	0.0%
2012	8.0%	2.0%	18.0%	68.0%	4.0%	0.0%
2017	9.8%	1.9%	17.6%	66.6%	4.9%	0.0%
2022	11.5%	1.9%	17.3%	65.3%	3.8%	0.0%

Source: Aircraft Mix Classification Summary, January 2004.

Percent Arrivals & Percent Touch and Gos

The percent of arrivals is the ratio of arrivals to total operations conducted by aircraft on an annual basis or other specified time interval. For purposes of this capacity analysis, arrivals will equal departures which yield a 50 percent arrival ratio. Percent touch and gos is the ratio of landings with an immediate takeoff to the total operational activity at the airport. With regard to touch and go activity at GCN, given the unique nature and operational environment of the airport coupled with the lack of flight training activity and high percentage of commercial aircraft operations at GCN, the percent touch and go ratio is equal to zero (0).

Exit Taxiway Locations
For purposes of calculating airfield capacity, an airport that has runways served by a full-length parallel taxiway, ample runway entrance/ exit taxiways, and exhibits few, if any, taxiway/runway crossing issues, capacity, as a general rule will not be adversely affected by high volumes of high operational tempo. However, minus all or even one of these taxiway attributes and an airport may in fact experience decreased capacity and increased levels of delay during period of peak aircraft demand.

The Grand Canyon National Park Airport is served by a full-length parallel taxiway designated Taxiway P. Additionally, Runway 3-21 at GCN is served by seven additional exit/ entrance taxiways designated Taxiways A, B, C, D, E, F and G with Taxiway D being a high speed exit taxiway tasked to serve the Runway 3 approach end. The siting and location of the taxiways serving Runway 3-21 are spaced at intervals ranging from 2,250 feet up to 3,550 feet between each taxiway. All but Taxiways F and G are 75 feet in width while F and G are 100 feet and 107 feet, respectively.

In studying the runway for FAR and taxiway siting and design criteria compliance, it appears that Taxiway A and B do not adhere to taxiway separation criteria for and ARC C-III facility in accordance with FAA AC 150/ 5300-13, *Airport Design.* Other than this discrepancy, it appears that there are no further adverse issues regarding the taxiway system as it affects demand capacity at GCN.

Runway Configuration
The Grand Canyon National Park Airport runway configuration consists of a single 8,999' x 150' runway, designated 3-21, situated along a 40.65^{o} true bearing. From a capacity standpoint, a single runway configuration offers the least capacity in terms of hourly operational capacity and Annual Service Volume (ASV) which are largely dependent on Mix Index, as well as the previously discussed factors affecting airfield capacity.

Mix Index, which is related to ASV, is defined as a mathematical expression of the percentage of Class C aircraft plus three times the percent of Class D aircraft (C+3D). Mix Index is important in that it is a computation of runway capacity. For instance, as the approach speeds and overall size of aircraft increase the operational capacity of an airport decreases. The reason for this is that heavy aircraft create more wake turbulence (vortices) that require greater spacing between and large and small aircraft, hence increasing Runway Occupancy Time (ROT) for departing aircraft and significant in-trail spacing for arriving aircraft thereby reducing airport capacity.

Annual Service Volume (ASV) & Hourly Capacity

Annual Service Volume (ASV) is utilized by the FAA as a means of reasonably quantifying the measure of an airport's annual capacity. An airport's ASV takes into account differences in runway use characteristics, aircraft mix, climatic conditions, percentage of aircraft arrivals and touch and gos and taxiway locations that can be expected to be encountered over a years' time.

ASV can be used by the airport sponsor as a gauge or reference point in measuring demand and determining the timing and necessity of planning for capacity-related developments at the airport. As the total number of annual aircraft operations approaches

the airport's ASV, annual aircraft delay increases dramatically with even small changes/ increases in aircraft traffic, weather conditions, or other disruptions. As a general rule it is recommended, when airport demand reaches 60 percent of its ASV (capacity), considerations and preparation need to be made to plan for capacity-related capital development. At such time that an airport is operating at 80 percent of its ASV, planned capacity-related improvements are recommended to be constructed.

Table 4.7 presents the calculated ASV for the Grand Canyon National Park Airport during each planning phase of the 20-year planning horizon. The aircraft mix/aircraft mix index (C+3D) information presented in Table 4.7 is predicated on the annual aircraft operations conducted by fixed wing aircraft. This includes the ratio (percentage) of Class C and Class D aircraft within the current aircraft mix operating at GCN now and during each planning phase of the 20 year development period. Rotorwing aircraft were excluded from calculating the ASV for the Grand Canyon National Park Airport because they often do not utilize the runways for landings or takeoffs.

Concluding the airfield capacity analysis for GCN it was determined that, given the unique operating environment of the airport coupled with the airport's single runway configuration, the hourly VMC/ VFR capacity for GCN is 55 fixed wing aircraft operations per hour. The hourly IMC/ IFR capacity of GCN is 53 fixed wing aircraft operations per hour. Furthermore, given Runway 3-21's configuration, in addition to the taxiway system designed to serve the runway, the ASV of the Grand Canyon National Park Airport throughout the planning period is 210,000 annual operations.

At the conclusion of the 20-year planning horizon it was determined that with an ASV of 210,000 and a projected annual demand of nearly 123,000 annual fixed wing aircraft operations, GCN's ratio of demand capacity to the ASV would be 0.59, or 59 percent. Planning for capacity-related improvements is considered to be needed when demand capacity reaches 60 percent of ASV.

Table 4.7
Airport Capacity and Delay Information
Grand Canyon National Park Airport

Software Calculations/ Input	Existing	2007	2012	2017	2022
Class C- Percent of Aircraft ≤ 12,500 lbs. & >300,000 lbs.	94%	92%	88%	87%	87%
Class D- Percent of Aircraft over 300,000 lbs.	0%	0%	0%	0%	0%
Mix Index (C+3D)	94%	92%	88%	87%	87%
Annual Demand (Operations)	49,000	96,000	100,000	109,000	123,000

Existing

Capacity (Ops/ Hour)		Annual Service Volume	Ratio of Average Demand to ASV	Average Delay per Aircraft (Minutes)		Minutes of Annual Delay (000)	
VMC/VFR	IMC/ IFR	(ASV)	(Percent)	Low	High	Low	High
55	53	210,000	0.23 (23%)	0.1	0.1	5,000	5,000

2007

Capacity (Ops/ Hour)		Annual Service Volume	Ratio of Average Demand to ASV	Average Delay per Aircraft (Minutes)		Minutes of Annual Delay (000)	
VMC/VFR	IMC/ IFR	(ASV)	(Percentage)	Low	High	Low	High
55	53	210,000	0.46 (46%)	0.3	0.4	29,000	38,000

2012

Capacity (Ops/ Hour)		Annual Service Volume	Ratio of Average Demand to ASV	Average Delay per Aircraft (Minutes)		Minutes of Annual Delay (000)	
VMC/VFR	IMC/ IFR	(ASV)	(Percentage)	Low	High	Low	High
55	53	210,000	0.48 (48%)	0.3	0.5	30,000	50,000

2017

Capacity (Ops/ Hour)		Annual Service Volume	Ratio of Average Demand to ASV	Average Delay per Aircraft (Minutes)		Minutes of Annual Delay (000)	
VMC/VFR	IMC/ IFR	(ASV)	(Percentage)	Low	High	Low	High
55	53	210,000	0.52 (52%)	0.4	0.5	44,000	54,000

2022

Capacity (Ops/ Hour)		Annual Service Volume	Ratio of Average Demand to ASV	Average Delay per Aircraft (Minutes)		Minutes of Annual Delay (000)	
VMC/VFR	IMC/ IFR	(ASV)	(Percentage)	Low	High	Low	High
55	53	210,000	0.59 (59%)	0.5	0.7	62,000	86,000

Note: Annual Demand does not include military aircraft operational activity.

Source: GCN Airport Capacity and Delay Summary, January 2004.

Hourly & Annual Delay

Delay is defined as the difference between constrained and unconstrained operating time and delay, expressed in average minutes per aircraft operation. Delay is an important measuring tool of an airport's ability to accommodate annual aircraft demand. Factors having the greatest amount of influence on delay include weather conditions, aircraft mix and ASV.

The airfield capacity analysis was conducted in accordance with FAA AC 150/ 5060-5, *Airport Capacity and Delay*, average delay in minutes in the year 2022 is estimated to be between 0.5 and 0.7 minutes of delay per aircraft operation at GCN. This ratio indicates that average delay per aircraft operation at GCN will range from a low of 30 seconds to a high of 42 seconds. According to FAA guidelines, an airport is considered to be congested when the average delay per aircraft operation exceeds five (5) minutes. Additionally, the practical capacity of an airport is reached when the average delay per aircraft operation ranges between four (4) to six (6) minutes, at which demand exceeds capacity and delay increases at an exponential rate.

For purposes of estimating annual delay at GCN, the projections and conclusions reached regarding ASV and demand capacity, it was determined that delay occurring at GCN during the 20 year planning period will not reach or surpass unacceptable levels.

Airport Demand Capacity Summary

The results of the demand capacity study for the Grand Canyon National Park Airport indicate that GCN demand capacity will rise to a level 59 percent of the Annual Service Volume (ASV) of 210,000 operations annually. As discussed in earlier sections, the threshold for developing strategies regarding capacity-related capital development normally occurs when 60 percent of ASV is reached. However, because GCN is projected to reach within one (1) percent of ASV, it will be recommended that capacity-related improvements such as dual parallel taxiways and increased hold areas be included as part of the future development program for the Grand Canyon National Park Airport.

Regarding hourly capacity at GCN, the existing and ultimate VFR and IFR hourly capacity for GCN was estimated to be 55 (VFR) and 53 (IFR) operations per hour, respectively. However, the *Airport Peaking Characteristics* study portion of this chapter concluded that the projected peak hour aircraft operation for the year 2022 is estimated to be 63 operations per hour. This conclusion indicates that peak hour operations will surpass the hourly capacity of 55 operations hourly at GCN during the long-term phase of airport development or about 2017. Although this fact is notable, it is not viewed as a critical development issue because peaking increases are anticipated to take place during peak, or busy, periods of activity which will likely occur during the month of August.

Airfield/ Airside Facility Requirements

The airside facility requirements for the Grand Canyon National Park Airport will be completed to determine the airside facility needs with respect to potential improvements for the runway length and width, taxiway system, navigational aids (NAVAIDS), pavement marking and airfield lighting, and runway incursion mitigation and technology improvements to increase airfield safety.

Although, from a capacity standpoint, future capacity-related development is recommended for the 20 year planning period, airside facility needs will be determined based on a single runway configuration and existing airfield facilities. This course of action is the most prudent due to the fact that the ultimate proposed configuration of the airfield, as well as additional facilities that might accompany capacity expansion has yet to be

determined. Ultimate airport expansion will be considered and evaluated in Chapter V, *Airport Alternatives.*

Runway Length Requirements

Runway length requirements were determined for each group of aircraft conducting flight operations at the Grand Canyon National Park Airport which included air carrier, air taxi/ commuter, and general aviation. Additionally, takeoff runway length requirements were calculated for each facet of aviation conducting operations at GCN.

In calculating the runway length requirements for GCN, information contained within aircraft manufacturers' performance manuals were consulted to arrive at overall runway length requirements with attention being paid to takeoff and landing field length requirements. In addition to aircraft manufacturers' performance characteristics such as engine type, aircraft takeoff weight and flap settings, several factors associated with the GCN airport operating environment were analyzed including airport elevation, mean maximum temperature, effective runway gradient, pavement condition (wet versus dry) and weather conditions.

It should be noted that although published aircraft manufacturers' performance manuals were consulted individual air carrier and commercial aircraft operators typically will operate according to their own runway length requirements and criteria. These company length requirements are often more stringent than those presented in aircraft operating manuals and are primarily based on safety and insurance purposes.

Existing Runway Length/ Runway Characteristics

GCN is served by a single runway configuration, designated Runway 3-21, that accommodates air carrier, air taxi/ commuter, as well as general aviation operational activity. Runway 3-21, composed mainly of Portland Cement Concrete (PCC), is 8,999' x 150' in dimension and is a Precision Instrument (PI) capable runway with approach visibility minimums as low as ½-mile and 200 foot minimum descent altitude. Runway 3-21 is not equipped with displaced threshold at either end providing arriving and departing aircraft a fully usable landing and takeoff length of 8,999 feet. Lastly, the effective runway gradient for Runway 3-21 with a 78.7 foot difference in runway end centerline elevations is 0.8 percent.

Takeoff Runway Length Requirements

Takeoff runway length requirements were calculated for air carrier, air taxi/ commuter, and general aviation aircraft conducting operations at GCN throughout the 20-year planning horizon. This section will discuss the takeoff lengths need by air carrier aircraft flowed by an analysis to determine the runway takeoff lengths for air taxi/ commuter aircraft, as well as general aviation aircraft identified within the airport inventory as frequently utilizing GCN's Runway 3-21.

Air Carrier Length Requirements

Air carrier takeoff length requirements were calculated by utilizing the aircraft manufacturers' performance and operating manuals for each aircraft identified as operating at GCN. Calculating the takeoff length requirement included taking into account weather conditions, airport operating environment, aircraft weight, as well as aircraft settings during the arrival phase of flight into GCN. Paramount to this discussion is the

subject of aircraft weight. For purposes of determining the required runway length, given the forecast passenger load factor for the turbine/ jet air carrier commercial service fleet mix, this analysis will assume 75 percent of maximum payload in addition to fuel weight and Operating Empty Weight (OEW) during departure from GCN.

During the completion of Chapter II, *Airport Inventory* an inventory of Part 121 air carriers consistently conducting operations and enplaning/deplaning passengers at GCN over that past five years was conducted. The research indicated that four Part 121 carriers provided charter and on-demand service to GCN from points as close as Las Vegas and Reno, NV to origins and destinations as far as the East Coast, Great Lakes Region, and the Midwest namely Miami, FL, Lansing, MI, and Colorado Springs, CO, respectively. Table 4.8 provides pertinent information regarding the Part 121 carriers operating at GCN, as well as providing information regarding each company's aircraft fleet.

In determining the takeoff runway length requirements for air carrier aircraft two different weather conditions can be utilized for purposes of runway length determination. The first, *standard day,* describes a 59° F day while the alternative is known as *hot day* which describes *standard day* + 27° F (STD+15° C). *Hot day* can be described as a day where the air temperature is approximately 86° F. The difference between the two comparisons is that the relative density of the air decreases at high temperatures, as well as higher altitudes. This high density altitude decreases the operating performance of the aircraft. As previously identified in the airport inventory chapter the mean max air temperature for GCN is 84° F occurring in the month of July. Therefore, *hot day* performance data will be used to determine takeoff runway length requirements for air carrier aircraft.

Table 4.8
Part 121 On-Demand/ Charter Air Carrier Information
Grand Canyon National Park Airport

Company Name	Headquarters Location	Aircraft Type	Passenger Seating*	Airport Reference Code (ARC)**
Miami Air International	Miami, FL	Boeing 727-200/ Boeing 737-800	155/ 175	C-III
Allegiant Air	Las Vegas, NV	McDonnell Douglas (Boeing) MD-82, -83 and -87	172/ 139	C-III
McClaskey Enterprises, LLC (d.b.a. Casino Express)	Elko, NV	Boeing 737-300	140	C-III
Planet Airways	Orlando, FL	Boeing 727-100/ 200	125/ 155	C-III

(*) All passenger seating capacity indicates single class economy configuration.

(**) ARC C-III classification has the following performance characteristics:
Aircraft Approach Category C- an approach speed of 121 knots or more, but less than 141 knots.
Airplane Design Group III- a wingspan of 79 feet up to but not including 118 feet in width.

Source: Part 121 Air Carrier Summary, January 2004.

Determining takeoff runway length requirements also require analysis of engine type, as well as thrust rating of the engines equipped on a particular aircraft. For purposes of this analysis, the engine type utilized for runway length determination will be those engines that are currently equipped on the commercial aircraft fleet offering the highest thrust rating

(thousands of pounds) at sea level. Additionally, flap settings for aircraft departure are critical in determining takeoff runway length requirements. Flap settings providing optimum performance per aircraft type will represent a standard operating condition for departure purposes and will be utilized in this takeoff runway length requirements analysis.

Upon analyzing the Part 121 air carriers and the geographical areas they serve, it is clear that there are two distinct markets that exist that influence the operational and passenger characteristics at GCN. Recognizing that these two distinct markets are primarily concentrated within the Desert Southwest, as well as the East Coast, two separate haul (stage) lengths will be utilized for this analysis. For flexibility, stage lengths of 500 nautical miles which encompasses a vast majority of origins and destinations within the Southwest while a stage length of 1,800 nautical miles represent the East Coast markets. Furthermore, it is assumed, for calculation purposes, that a vast majority of the flights to and from either market centers are non-stop flights. Table 4.9 depicts the takeoff runway length requirements for the Part 121 air carrier commercial fleet conducting operations within the 500 nautical mile stage length serving the Desert Southwest Region of the United States at GCN during hot day conditions.

Table 4.9
Air Carrier Takeoff Runway Length Requirements- 500 Nautical Mile Haul Length
Grand Canyon National Park Airport

Assumptions/ Input	Characteristic
Airport elevation	6,608.7' MSL
Wind Velocity	Zero
Runway Gradient	Zero
Bleed Air for Air Conditioning	None
Runway Surface	Wet and Smooth
Weather Condition Takeoff Requirement	Standard Day + 27° F (Unless Otherwise Noted)
Boeing 727-100 Weather Condition Takeoff Requirement	Standard Day + 25° F
Boeing 727-200 Weather Condition Takeoff Requirement	Standard Day + 25° F
Passenger/ Payload Percentage	75%
Boeing 727-100/ 737-300 Flap Setting	15 degrees
Boeing 727-200 Flap Setting	20 degrees
Boeing 737-800 Flap Setting	5 degrees
MD-82, -83, -87 Series Flap Setting	Nominal

	Aircraft Takeoff Weights (lbs.)			Total Takeoff Weight	Percentage of Max Takeoff Weight	Takeoff Runway Length Requirement
Aircraft Type	Fuel	Payload	OEW			
Boeing 727-100	26,600	22,800	87,600	137,000	85.6%	8,400 feet
Boeing 727-200	35,100	30,300	97,600	163,000	94.7%	9,100 feet
Boeing 737-300	12,990	25,470	72,540	111,000	80.1%	6,100 feet
Boeing 737-800	13,000	33,525	91,300	137,825	79.8%	7,500 feet
MD-82	17,006	33,018	77,976	128,000	85.6%	8,500 feet
MD-83	15,578	31,736	79,686	127,000	79.3%	8,000 feet
MD-87	14,681	29,045	73,274	117,000	83.5%	6,600 feet

Source: Boeing Commercial Airplane Group, Renton, Washington, January 2004.

The takeoff runway length analysis for the 500 nautical mile short haul length scenario purports to show that all aircraft, with the exception of the Boeing 727-200, operating within the Part 121 commercial service fleet can operate from Runway 3-21's current length of 8,999 feet. Additionally, according to the runway length requirements calculation, Runway 3-21 is capable of accommodating 79 to 85 percent of the available payloads of approximately 86 percent of the Part 121 air carrier aircraft fleet operating on short haul routes.

It should be noted that company fuel reserves which would add additional fuel weight to the runway length calculation were not included into the analysis as different companies operate aircraft with different fuel reserve parameters. Therefore, although additional takeoff distance may be required for departure, the overall impact of additional fuel reserves to the takeoff runway length requirements are not viewed as a critical condition for operation at the airport. As is standard practice, when weather conditions and airport operating environment exceed performance characteristics of an aircraft, the aircraft will have limited payloads or a limited fuel load during period of adverse operating conditions. Table 4.10 depicts the takeoff runway length requirements for the Part 121 air carrier commercial fleet conducting operations within the 1,800 nautical mile stage length serving primarily the East Coast of the United States from GCN during hot day conditions. Runway length requirements characteristics, inputs and assumptions including Operating Empty

Weight (OEW), as well as aircraft payload are the same as those relied on for determining the 500 nautical mile stage length takeoff runway requirements. However, the overall fuel weight calculations utilized as part of the runway length requirements for aircraft originating from or departing for destinations of 1,800 nautical miles will increase due to the amount of fuel needed to fly a long haul route from GCN during a hot day.

Table 4.10
Air Carrier Takeoff Runway Length Requirements- 1,800 Nautical Mile Haul Length
Grand Canyon National Park Airport

Assumptions/ Input	Characteristic
Airport elevation	6,608.7' MSL
Wind Velocity	Zero
Runway Gradient	Zero
Bleed Air for Air Conditioning	None
Runway Surface	Wet and Smooth
Weather Condition Takeoff Requirement	Standard Day + 27° F (Unless Otherwise Noted)
Boeing 727-100 Weather Condition Takeoff Requirement	Standard Day + 25° F
Boeing 727-200 Weather Condition Takeoff Requirement	Standard Day + 25° F
Passenger/ Payload Percentage	75%
Boeing 727-100/ 737-300 Flap Setting	5 degrees
Boeing 727-200 Flap Setting	20 degrees
Boeing 737-800 Flap Setting	5 degrees
MD-82, -83, -87 Series Flap Setting	Nominal
Boeing 727-200 (Advanced) Option	197,000 lbs. Max. Takeoff Weight (MTOW)
Boeing 727-200 (Advanced Fuel) Option	70,800 lb. (10,570 gal.) Fuel Capacity

	Aircraft Takeoff Weights (lbs.)			Total Takeoff Weight	Percentage of Max Takeoff Weight	Takeoff Runway Length Requirement
Aircraft Type	Fuel	Payload	OEW			
Boeing 727-100	49,600	22,800	87,600	160,000	100.0%	Unusable
Boeing 727-200	61,490	31,470	98,040	191,000	96.9%	Unusable
Boeing 737-300	29,900	25,470	72,540	128,000	92.4%	9,700 feet
Boeing 737-800	30,175	33,525	91,300	155,000	89.8%	9,300 feet
MD-82	36,006	33,018	77,976	147,000	98.3%	Unusable
MD-83	34,578	31,736	79,686	146,000	91.2%	Unusable
MD-87	30,681	29,045	73,274	133,000	88.9%	9,500 feet

Source: Boeing Commercial Airplane Group, Renton, Washington, January 2004.

The underlying purpose of determining takeoff runway lengths for long haul routes is not to investigate the feasibility of establishing non-stop service to the East Coast, but to illustrate the demand activity by Part 121 air carriers that utilize GCN on a regular basis. Also, the takeoff runway length analysis for long haul routes was conducted as a means by which to gauge the adequacy of Runway 3-21 to accommodate large air carrier aircraft during periods of extreme weather conditions (hot day conditions). By determining what the demand is, in addition to identifying runway operating capabilities, an objective assessment can be made as to what the future runway length requirements will be in the future airport development phases.

The takeoff runway length analysis for the 1,800 nautical mile long haul length scenario purports to show that the Boeing 727-100 and 200 series, as well as the MD-82 and 83 series aircraft, given the airport operating environment coupled with the range limitations of the aircraft would be unable to operate from GCN on a long haul route to the East Coast

without substantial payload limitations. Although, these aircraft are capable of arriving at GCN from a long haul originating point, it is apparent that the Boeing 727 series aircraft arrive at GCN and depart to another location to take on necessary fuel to proceed back the East Coast. Likewise, it is also apparent that the MD-82 and -83 series aircraft, although capable of long haul route transport, likely arrive at GCN and depart in the same manner and fuel/ payload configuration as the Boeing series aircraft. This notion also bolsters the fact that MD-82 and -83 series aircraft are utilized primarily for short haul routes throughout the Desert Southwest by Allegiant Air with GCN being a frequent destination.

Table 4.10, depicted in the preceding page, indicates that Runway 3-21 with its current length of 8,999 feet is inadequate to accommodate existing Part 121, as well as future, air carriers during periods of hot day weather conditions without substantial weight (fuel or payload) limitations for long haul routes. The takeoff runway length analysis concludes that a 9,700 foot runway would allow 43 percent of the existing Part 121 activity demand to adequately serve East Coast markets during extreme weather conditions, and may be preferred at GCN for the long-term development plan. It can also be inferred that a 9,700 foot runway would accommodate 100 percent of ultimate demand in that the Boeing 727 and MD-82 and -83 series aircraft are being phased out by newer, more efficient aircraft with increase operational performance such as the Boeing 727-300/ 400/ 500 series, as well as the Next Generation of Boeing 737s including the 800 series.

Air Carrier Length Requirement Summary
Realizing that during hot day conditions Part 121 air carrier demand at GCN requires a minimum of 9,700 feet or runway length, consideration needs to be given additional factors that potentially require additional runway length requirements for GCN. Initially, this analysis takes into consideration many factors that are in accord with aircraft manufacturer performance standards for design purposes that may not particularly represent “real world” conditions. Also, relying on industry accepted FAA aerospace forecasts, assumptions have been made regarding the passenger load factor (75 percent) in accordance with forecast demand at GCN for planning purposes. The typical industry level for acceptable payload ranges between 75 percent and 85 percent while at the same time some airlines generally prefer not to operate below 90 percent of their available payloads for cost purposes. This premise indicates a possible need for additional runway length.

Aircraft performance characteristics and assumptions utilized to determine the takeoff runway length analysis also indicated a possible need for additional runway length. For instance, according to manufacturers’ performance characteristics, runway gradient is not considered for determining aircraft performance. GCN’s runway gradient is 0.8 percent indicated a runway end elevation difference of nearly 79 feet affecting aircraft performance during hot day conditions. Lastly, performance charts indicate that bleed air for cabin air conditioning is indicated at zero. During hot day conditions it can be assumed that the cabin air conditioning system would be in operation thereby decreasing engine performance and affecting overall aircraft takeoff performance.

In accordance with the above discussion, it is the consultants’ recommendation that future runway development include consideration of planning for an ultimate Runway 3-21 length of 10,000 feet to account for extreme hot day airport and aircraft operating conditions.

Air Taxi/Commuter & General Aviation Length Requirements
Takeoff runway length requirements at GCN for air taxi/ commuter, as well as general aviation aircraft were calculated in accordance with FAA AC 150/ 5325-4A, *Runway Length Requirements* design program version 4.1. Table 4.11 illustrates the recommended runway length requirements for air taxi/ commuter and general aviation aircraft based on current and forecast activity demand. Recommended runway lengths are based on aircraft performance characteristics, as well as airfield conditions utilizing the following input factors: 1) the airport elevation (6,608.7 feet mean sea level - compensating for the affects of density altitude and no wind); 2) the average mean maximum daily temperature (84°F) for the hottest month (July); 3) the effective runway gradient (78.7 foot elevation difference between runway ends- 0.8 percent); and 4) wet versus dry smooth runway conditions.

Takeoff runway length requirements for air taxi/ commuter aircraft were calculated assuming maximum gross takeoff weight during hot day weather conditions. Aircraft representative of this grouping of aircraft include 15 and 19 passenger seat turbo prop, as well as twin piston powered aircraft weighing in excess of 12,500 pounds. According to the analysis, during hot day conditions, a runway length of 8,000 feet is sufficient to accommodate 100 percent of the air taxi/commuter aircraft fleet.

General aviation aircraft takeoff runway length requirements were determined assuming maximum gross takeoff weight during hot day weather conditions. Aircraft representative of the general aviation family of aircraft include single and twin piston powered aircraft weighing less than 12,500 pounds. A typical runway length of 5,600 feet is required to accommodate the majority of the higher performance single and twin engine piston powered general aviation aircraft at GCN. Aircraft equipped with normally aspirated, carbureted powered engines will generally require longer runway length due to the affects of high density altitudes as it affects aircraft power plant performance. In addition to piston powered single and twin engine aircraft, cabin class business jet/ turbine aircraft are included as part of the general aviation fleet of aircraft. Assuming maximum takeoff weight during hot day conditions, a runway length of 8,100 feet is required to accommodate large general aviation business jet aircraft weighing in excess of 12,500 pounds.

Table 4.11
Air Taxi/ Commuter & General Aviation Takeoff Runway Length Requirements
Grand Canyon National Park Airport

Airport and Runway Data	Input	Input
Airport elevation	6,608.7' MSL	6,608.7' MSL
Mean daily maximum temperature of the hottest month	84.0° F	84.0° F
Maximum difference in runway centerline elevation	78.7 feet	78.7 feet
Aircraft Information/ Corresponding ARC	**Length-Dry**	**Length-Wet**
Small airplanes with less than 10 passenger seats:		
75 percent of these small airplanes (ARC A-I)	5,610'	5,610'
95 percent of these small airplanes (ARC B-I)	7,930'	7,930'
100 percent of these small airplanes (ARC B-II)	7,930'	7,930'
Small airplanes with 10 or more passenger seats (ARC B-II+10)	7,930'	7,930'
Large airplanes less than 60,000 pounds:		
75 percent of these large airplanes at 60 percent useful load (ARC C-II)	8,050'	8,050'

Note: The recommended runway length is rounded to the next 100 foot increment beyond 30 feet.
Note: Aircraft Approach Category A = Approach speed less than 91 knots
Aircraft Approach Category B = Approach speed of 91 knots or more but less than 121 knots
Aircraft Approach Category C = an approach speed of 121 knots or more, but less than 141 knots.
Note: Airplane Design Group I = Wingspan up to but not including 49 feet.
Airplane Design Group II = Wingspan of 49 feet up to but not including 79 feet .

Source: AC 150/ 5325-4A, *Runway Length Requirements for Airport Design,* Chapter II.

Table 4.12 summarizes the takeoff runway length and dimension requirements for the Grand Canyon National Park Airport for air carrier, air taxi/ commuter and general aviation aircraft demand.

Table 4.12
Takeoff Runway Length Requirements Summary
Grand Canyon National Park Airport

Aircraft Grouping	Recommended Runway Length/ Dimension Requirement
Part 121 Air Carrier	9,700' x 150'*
Part 121 Air Carrier (Extreme Conditions)	10,000' x 150'
Air Taxi/ Commuter	8,000' x 100'**
General Aviation (Piston Engine)	5,600' x 100'
General Aviation (Turbine/ Jet)	8,100' x 100'

(*) Indicates necessary runway dimension for Design Group III airport serving aircraft with maximum operating weights greater than 150,000 pounds per FAA AC 150/ 5300-13, *Airport Design*.

(**) Indicates necessary runway dimension for Design Group II aircraft operating at an Approach Category C airport per FAA AC 150/ 5300-13, *Airport Design*.

Source: Takeoff Runway Length Requirements Summary, January 2004.

Future Critical/ Design Aircraft Designation

Table 4.13 provides information regarding the ultimate critical/ design aircraft for the Grand Canyon National Park Airport. The critical aircraft is the largest airplane type conducting at least 500 projected annual itinerant operations (combination of 250 takeoffs and landings) per year at GCN.

The future critical aircraft for GCN, identified by application of the forecast of commercial aircraft fleet mix and itinerant activity, runway length requirements and Aircraft Rescue and Firefighting (ARFF) Index designation is a large cabin class twin turbofan aircraft in the ARC C-III classification of aircraft. This aircraft type was selected based on current airport usage, and forecast estimates for activity by large aircraft conducting air carrier and air charter operations at GCN. A common twin turbofan passenger aircraft representative of the ARC C-III classification is the Boeing 737-800 Next Generation series airliner which can accommodate 160-184 passengers under alternative passenger seating configurations. It should be noted that, although the Boeing 737-300 series requires a longer runway length for takeoff purposes, it is projected to be phased out during the 20 year GCN planning period. Additionally, the Boring 737-800 series places a heavier demand on the airfield facilities in terms of wing span, approach speed, operating weight and overall length and size of the airframe.

Taxiway Requirements

The taxiway system exists expressly to serve as a defined area to accommodate the movement of aircraft to and from the runway, as well as to serve as a transit system between the airside and terminal area complex. This section will evaluate the capability of the taxiway system at GCN to accommodate existing and ultimate demand activity. Additionally, this taxiway analysis will identify area of the taxiway system that pose potential inadequacies with regard to taxiway flow or adversely affect airfield design criteria.

Parallel Taxiway

Runway 3-21 is served by a 8,999' x 75' full length parallel taxiway designated Taxiway P and is constructed of Portland Cement Concrete (PCC). The overall condition of the taxiway surface appears to be in good physical condition. Taxiway P is located to the southeast of Runway 3-21, providing direct and unimpeded access to the airport terminal area and aircraft parking apron, and is separated by a runway centerline-parallel taxiway centerline distance of 400 feet which adheres to airport taxiway design criteria. However, the standard taxiway width for taxiways serving a Design Group III facility is 50 feet in width.

According to the analysis of Taxiway P, it appears that this taxiway is sufficient to accommodate the current and future activity demand for GCN throughout the planning period. Upon extension of Runway 3-21 to the recommended runway length of 10,000 feet, Taxiway P is recommended to be extended by 1,001' x 50' to provide access/ egress to/ from Runway 3-21. Lastly, to adhere to airport taxiway design criteria, Taxiway P is recommended to be narrowed to the design width of 50 feet and marked accordingly.

Entrance & Exit Connector Taxiways

GCN is equipped with seven entrance/exit taxiways designated A, B, C, D, E, F and G. Taxiways A through E measure 75 feet in width while F and G measure 100 feet and 107 feet, respectively. Taxiway D is designated as a high speed exit taxiway utilized primarily during periods of peak operational activity. As stated above, the standard taxiway width for taxiways serving a Design Group III facility is 50 feet in width. For purposes of providing optimum exit times from the runway at peak periods of activity, acute-angled taxiways are ideal but fillet and lead-in to fillets can be designed to accommodate rapid egress from the runways for right angled taxiways. Taxiway dimensions for fillets for Design Group III

facilities are 100 radius for the taxiway turn and 150 feet for the length of the lead-in to the fillet.

Table 4.13
Ultimate Critical Aircraft Information
Grand Canyon National Park Airport

Aircraft Type & Airport Reference Code (ARC)	Boeing 737-800 Series (ARC C-III)
Wing Span	112' 7"
Length Overall	124' 9"
Height Overall	41' 2"
Accommodations	6 Crew/ 160-184 Passengers (Mixed Class)
Maximum Takeoff Weight (MTOW)	172,500 lbs.
Approach Speed	139 knots
Takeoff Field Length Performance	9,300 feet
Design Range, Max Passenger Load	3,371 miles

Source: Boeing Commercial Airplane Group, Renton, Washington, January 2004.

Miami Air 737-800 Series Profile View (Final Approach)

One inadequacy noted during the taxiway requirement analysis is that the parallel taxiway centerline separation between Taxiways A and B is 150 feet in length. Taxiway design criteria for Design Group III facilities recommend 152 feet separation. Also, Taxiway A intersects the midpoint of Taxiway B which potentially creates a hazard in this area for aircraft conducting ground maneuvering operations.

In summary, it is recommended that Taxiways A through G be narrowed to 50 feet in width in accordance with Design Group III taxiway criteria. Also, taxiway fillets and fillet lead-ins are recommended to be inspected to ensure Design Group III taxiway fillet compliance. Next, Taxiway A is recommended to be closed and abandoned due to the hazard posed by its location and siting. Lastly, Taxiway E is recommended to be reconstructed and reconfigured to an acute-angle taxiway to provide a high speed exit taxiway providing egress from Runway 3-21 during peak period of aircraft activity.

Aircraft Bypass Area/ Holding Bays
Aircraft bypass areas or run-up areas are primarily utilized to stage aircraft prior to takeoff. Bypass area can be used by aircraft to perform pre-flight engine run-ups and instrumentation adjustment or checks prior to departure. Bypass areas can be utilized by air carrier, air taxi/ commuter and general aviation aircraft.

Currently, GCN is not equipped with bypass areas for aircraft departure preparation. Therefore, it is recommended that, due to the wide variation of fleet mix of aircraft at GCN, bypass area/ holding bays be constructed at each approach/ departure end of Runway 3-21. These bypass areas are recommended to accommodate Boeing 737-800 series aircraft. Table 4.14 identifies the taxiway requirements for the Grand Canyon National Park Airport.

Table 4.14
Taxiway Facility Requirements Summary
Grand Canyon National Park Airport

Taxiway Facility Type	Recommendations
Parallel Taxiway	Extend Taxiway P by 1,001' x 50' to serve proposed 10,000 foot runway length
	Narrow entire length of Taxiway P to 50 foot width
Entrance & Exit/ Connector Taxiways	Narrow Taxiways A through G to 50 foot width
	Ensure taxiway fillets adhere to Design Group III criteria
	Close/ abandon Taxiway A
	Reconfigure Taxiway E to serve as high speed exit taxiway for Runway 3 end
Aircraft Bypass Areas	Construct at ends of Runway 3-21 to accommodate Boeing 737-800 series aircraft

Source: Taxiway Facility Requirement Summary, January 2004.

Airfield Pavement Condition Requirements

Pavement conditions at GCN were inventoried and evaluated in 2003 as part of the ADOT, Aeronautics Division's Arizona Pavement Preservation Program (APPP). The Arizona Pavement Management System (APMS) evaluated and assessed GCN's pavement condition with respect to Pavement Condition Index (PCI), physical condition and potential rehabilitation recommendations. The overall weighted PCI Index of the Portland Cement Concrete (PCC) paved surfaces at GCN was recorded as 89- Very Good. Table 4.15

reveals pertinent information regarding paved surfaces at GCN with respect to PCI, weight bearing strength, and physical characteristics.

Table 4.15
Airfield Pavement Condition Inventory
Grand Canyon National Park Airport

Component	*Pavement Condition Index (PCI)*	*Weight Bearing Capacity (lbs.)*	*Physical Characteristics* *Distress Type*	*Distress Severity*
Runway System				
Runway 3-21	82- Very Good	108,000 lbs. (DW)	Cracking/ Raveling/ Weathering/ Swelling	Low
Taxiway System				
Taxiway A Taxiway B Taxiway C	96- Excellent	108,000 lbs. (DW)	Cracking	Low
Taxiway D	96- Excellent	108,000 lbs. (DW)	Cracking	Medium- High
Taxiway E Taxiway F Taxiway G Taxiway P	96- Excellent	108,000 lbs. (DW)	Cracking	Low
Airport Apron Areas				
Section 10	54- Fair	108,000 lbs. (DW)	Cracking	Medium- High
Section 15	99- Excellent		Spalling, Cracking	Low
Section 20	96- Excellent		Cracking	Low

(DW) indicates dual wheel landing gear configuration.
Note: Section 10 is a portion of the southern/ transient apron area.
Section 15 is a small potion of the south central apron area.
Section 20 consists of the north, central and portion of the southern/ transient apron.

Source: APTech, 2003 Airport Pavement Management System Update; FAA Form 5010 (12/25/03).

In summary, based on the 2003 APMS and in accordance with APPP, apron area section 10 is to be milled and rehabilitated during the latter part of Phase I (2007) of ultimate airport development. Continued monitoring of pavement condition and distress factors by airport operations personnel are recommended throughout the planning period.

Navigational Aid (NAVAID)/ Instrumentation Requirements

Airport navigation aids (NAVAIDS) are installed on or near airports to increase an airport's reliability and efficiency to accommodate aircraft operations during night and inclement weather conditions, as well as to provide electronic guidance and visual references for executing an approach to the airport.

Instrument Landing System (ILS)
An ILS provides aircrews with horizontal situational awareness (course left or right of runway centerline) and vertical situational awareness (angle of descent above or below glide path) to align an aircraft with the runway centerline so that an approach can be made during inclement weather conditions. Components of an ILS include the glideslope antenna/ transmitter (GS) which projects a radio frequency extending five to seven miles from the runway at a fixed vertical slope of approximately three degrees that provides height information; a localizer (LOC) beam radiating down the extended runway centerline providing course information; and outer (OM), middle (MM) and inner markers (IM) to provide distance information from the runway approach end.

GCN is equipped with an ILS to provide IMC/IFR approach capabilities to Runway 3. A discussion of IMC/ IFR conditions (cloud ceilings ≥ 1,000 feet and visibilities ≥ three miles) at GCN is presented at the beginning of this chapter contained in page 4-7, *Airfield Capacity Analysis, Meteorological Conditions.* CAT I weather conditions (ceilings > 400 and/or visibilities > one mile; but Ceiling ≤ 200 feet and visibility ≤ ½-mile) are primarily when the ILS is utilized. CAT I conditions occur approximately three days per year.

Very High Frequency Omni-Directional Radio Range (VOR-DME)
A discussion highlighting the VOR-DME facilities at GCN are detailed in Chapter II, *Airport Inventory,* page 2-31, *En-Route Navigation Aids (NAVAIDS).* As pointed out above, CAT I weather conditions occur approximately three (3) days per year requiring the use of the ILS, while the remaining IMC/ IFR conditions, approximately 11 days per year, can be accommodated by a VOR-DME instrument approach to Runway 3. Additional information regarding approach capabilities at GCN are detailed in Chapter II, *Airport Inventory*, page 2-35, Table 2.20.

Automated Surface Observation System (ASOS)
Information and discussion regarding the GCN ASOS, commissioned in May 1998, are detailed in Chapter II, *Airport Inventory*, pages 2-24 and 2-25. An analysis of the NAVAIDS and ASOS facility located at GCN concludes that NAVAID and ASOS services provided are sufficient to accommodate the existing and ultimate demand activity anticipated to utilize the Airport.

Airfield Markings, Lighting & Signage Requirements

Airfield Markings
Airport markings were previously described in Chapter II, page 2-9, Table 2.7. Runways, taxiways, taxilanes and apron areas are marked in accordance with FAA AC 150/5340-1H, *Standards for Airport Markings*, as well as the Grand Canyon National Park Airport Certification Manual per 14 CFR, FAR Part 139, *Certification and Operations: Land Airports Serving Certified, Scheduled Air Carrier Operating Large Aircraft*.

Airfield Lighting
Airfield lighting for GCN was previously described in Chapter II, page 2-9, Table 2.7. This section will offer additional information and explanation regarding the lighting systems identified in Table 2.9.

Runway and Taxiway Lighting: Runway 3-21 is equipped with white colored omni-directional, ATC/ pilot controlled Medium Intensity Runway Lighting (MIRL) defining the lateral and longitudinal limits of the runway. Additionally, GCN's taxiway system is equipped with blue omni-directional Medium Intensity Taxiway Lighting (MITL). GCN's runway and taxiway lighting systems currently adhere to requirements as prescribed in FAA AC 150/ 5340-24*, Runway and Taxiway Edge Lighting System.*

Approach Lighting System (ALS): Runway 3 is equipped with a Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR) and is utilized in conjunction with the ILS to aid in identifying the airport environment while conducting approaches in IMC/ IFR weather conditions. GCN's MALSR is maintained and operated in accordance with FAA Order 6850.2A, *Visual Guidance Lighting Systems.*

Runway End Identifier Lights (REILs): Runway 21 is equipped with this ATC/pilot controlled lighting system providing rapid and positive identification of the runway approach end there is a lack of visual acuity and contrast with the surrounding landscape. The REIL lighting system consists of a pair of white synchronized high-intensity photo-strobe lights located laterally along the runway threshold. GCN's REIL system is maintained and operated in accordance with FAA Order 6850.2A, *Visual Guidance Lighting Systems.*

Visual Guidance Indicators: Visual Approach Slope Indicators (VASI-4L), equipped on Runway 21, emits a sequence of colored light beams providing continuous visual descent guidance information along the desired final approach descent path (normally at 3 degrees for 3 nautical miles during daytime, and up to 5 nautical miles at night) to the runway touchdown point. The VASI system consists of a four lamp housing unit installed 600 to 800 feet down the runway and offset 50 feet to the left side. GCN's VASI system is installed, maintained and operated in accordance with FAA Order 6850.2A, *Visual Guidance Lighting Systems.*

Wind Indicator/Segmented Circle and Airport Beacon: GCN is equipped with a dual-colored red and white segmented circle with a lighted wind indicator/wind sock providing an indication of the wind direction and airport traffic pattern in the vicinity of the airport. Additionally, GCN is equipped with supplemental wind indicators at both runway ends per FAR Part 139 airport certification mandates.

The GCN airport beacon, emiting a white-green flash of light at a rate of two to five times per minute, provides visual airport identification and location during night-time operations, as well as during inclement weather conditions (IFR). The light emitted from the GCN beacon is angled from one to ten degrees above the horizon taking into account the surrounding terrain.

Airfield Signage
Airport signage at GCN provides mandatory instructions, runway and taxiway location, directional and destination information, as well as airport special informational signage providing awareness for aircraft maneuvering on the ground. Airfield signage at GCN is implemented and maintained in accordance with FAA AC 150/5345-44F*, Specifications for Taxiway and Runway Signs* and FAA AC 150/5340-18C*, Standards for Airport Sign Systems*, as well as the GCN Airport Certification Manual as required by FAR Part 139 mandate.

Airport Design Standards

Table 4.16 provides airport geometric standards and recommendation in order to ensure safety and efficiency at airports as published within FAA AC 150/ 5300-13, *Airport Design.* The following discussion defines particular safety areas and surfaces referenced in Table 4.16 as they influence existing and ultimate design standards for GCN.

Runway Safety Area (RSA): The RSA is a two-dimensional surface surrounding the runway prepared or suitable for reducing the risk of damage to airplanes in the event of undershoot, overshoot, or excursion from the runway.

Object Free Area (OFA): The OFA is a two-dimensional area on the ground centered on the runway, taxiway, or taxilane centerline provided to enhance the safety of aircraft operations by having the area free of objects, except for those that need to be located in the OFA for air navigation or aircraft ground maneuvering purposes.

Building Restriction Line (BRL): The BRL represents the boundary that delineates the airside and landside of the airport, and identifies area on airport property suitable for building area locations based on airspace and visibility restrictions. The BRL, recommended to provide at 35 feet above ground clearance, is established with reference to FAR Part 77 criteria, in addition to other design factors.

Runway Protection Zone (RPZ): The purpose of the RPZ is to enhance the protection of people and property on the ground, and to prevent obstructions to aircraft. The RPZ is a two-dimensional trapezoid area beginning 200 feet beyond the paved runway end, and extends along the runway centerline. The RPZ size is determined by the Aircraft Approach Category of airplanes expected to utilize the airport, as well as the type of instrument approach or minimum visibility to the runway ends (visual; non-precision and precision with not lower than 1-mile; ¾-mile; or as low as ½-mile). The FAA recommends that airport sponsor own the RPZ property in fee simple, and that the RPZ be clear of any non-aeronautical structure of public assembly or object that would interfere with the arrival and departure of aircraft.

Table 4.16
Airport Design Standards
Grand Canyon National Park Airport

	Runway 3		Runway 21	
Runway Design Factors	Existing	Ultimate	Existing	Ultimate
Airport Reference Code (ARC)	C-III	C-III	C-III	C-III
Runway Length	8,999'	10,000'	8,999'	10,000'
Runway Width	150'	150'	150'	150'
Runway Safety Area (RSA):				
RSA width	500'	500'	500'	500'
RSA length beyond runway end	1,000'	1,000'	1,000'	1,000'
Object Free Area (OFA):				
OFA width	800'	800'	800'	800'
OFA length beyond runway end	1,000'	1,000'	1,000'	1,000'
Building Restriction Line (BRL)	745' from centerline	745' from centerline	745' from centerline	745' from centerline
Runway Obstacle Free Zone (ROFZ):				
ROFZ width	400'	400'	400'	400'
ROFZ length beyond runway end	200'	200'	200'	200'
Runway Protection Zone (RPZ):				
Inner width	1,000'	1,000'	500'	500'
Length	1,750'	1,750'	1,700'	1,700'
Outer width	2,500'	2,500'	1,010'	1,010'
RPZ Size (Acres)	(size: 78.914)	(size: 78.914)	(size: 29.465)	(size: 29.465)
Approach Surface (FAR Part 77):	½-mile	½-mile	1-mile	1-mile
Inner width	1,000'	1,000'	500'	500'
Length	50,000'	50,000'	10,000'	10,000'
Outer width	16,000'	16,000'	3,400'	3,400'
FAR Part 77 Primary Surface:				
Width	1,000'	1,000'	1,000'	1,000'
Length beyond runway end	200'	200'	200'	200'
Approach Slope (FAR Part 77):	50:1	50:1	34:1	34:1
Approach Lighting System (ALS)	MALSR	MALSR	Not Equipped	Not Equipped
Runway to Taxiway CL Distance	400'	400'	400'	400'
Runway to Parking Apron Distance	500'	500'	500'	500'
Runway to Taxiway Hold Line	250'	250'	250'	250'

Source: FAA AC 150/ 5300-13, *Airport Design*, Change 7.

It was discovered during the airport inventory that the structure owned and operated by Papillion Grand Canyon Helicopters is located within the RPZ for Runway 21. Per FAA guidelines, structures and places of public assembly are expressly prohibited from being located within the RPZ. Therefore, this matter will be discussed, evaluated and a mitigative course of action will be proposed in Chapter 5, *Airport Development Alternatives.*

Runway Obstacle Free Zone (ROFZ): The OFZ is the airspace below 150 feet above the a established airport elevation and centered on the runway centerline that is required to be clear of all objects, except for frangible visual post mounted NAVAIDS expressly located in the OFZ by function, in order to provide

clearance protection for aircraft landing or raking off from the runway, and for missed approaches.

FAR Part 77 Approach Slope/Surface: The approach slope is a three-dimensional trapezoidal area beyond each runway end having a defined slope for clearance over structures and objects beyond the runway threshold. The purpose of the approach slope/surface is to provide proper clearance for the efficient and safe approach and departure of aircraft.

With exception of the encroachment of the RPZ for Runway 21 by a structure, the remaining airport geometric design standards are in accordance with applicable Federal Aviation Regulations (FARs) and Advisory Circulars (ACs).

Technology Improvements

Given the existing and ultimate operational tempo of the Grand Canyon National Park Airport, an analysis of technological improvements designed to enhance safety and efficient was completed. This analysis will not specifically recommend any particular safety enhancement but merely provide insight to the potential application of emerging technologies at GCN.

In particular, technology improvements most likely to increase the safety and efficiency of GCN are those technologies designed to decrease the likelihood of a runway incursion. A runway incursion is defined as any occurrence at an airport involving an aircraft, vehicle, person or object on the ground that creates a collision hazard or results in loss of separation with an aircraft taking off, intending to takeoff, landing, or intending to land.

A runway incursion can occur during day or night VMC/ VFR or IMC/ IFR conditions, although most incursions occur at dusk/ sunset/ night or during IMC/ IFR weather conditions. Although operational activity and IMC/ IFR weather conditions occur only a fraction of the time throughout the year at GCN, attention needs to be given to the reduction of such occurrences.

Runway Incursions

In 1991 the FAA Runway Safety Program (RSP) instituted the Runway Incursion Reaction Team (RIAT). The FAA RSP, in joint cooperation with commercial service airport operators, began establishing RIATs to identify and make recommendations to correct potential runway incursion problems at selected airports. The teams focus on ground movements through complex or problem intersections, air traffic procedures, ground vehicle operations, and pilot education and awareness. Airport user involvement is critical to the success of the RIATs and local airlines and tenants are invited to attend the RIAT meetings.

It is recommended that the ADOT, Aeronautics Division contact the FAA, Western Pacific Region, with regards to scheduling a RIAT inspection of GCN within the short-term phase of airport development.

Commercial Service Aircraft Apron Area Requirements

The GCN apron area, measuring approximately 95,600 square yards (860,400 square feet) of space, is designed to accommodate commercial service and general aviation aircraft both based and itinerant aircraft not stored in hangars while providing access to the airfield, as well as the terminal are component of the airport. This analysis will determine the recommended apron area to accommodate primarily air carrier and air taxi/commuter aircraft during peak periods of aircraft operational activity at GCN. Table 4.17 indicates the necessary apron area requirements to accommodate commercial service aircraft during peak hour periods of activity.

The current GCN apron areas are discussed in Chapter II, Table 2.9 indicating that GCN accommodates approximately 30,000 square yards of commercial apron area (270,000 square feet), 14,600 square yards of general aviation apron area (131,400 square feet) and approximately 51,000 square yards (459,000 square feet) of transient apron located to the south of the main apron. The air carrier apron is utilized by single engine through 19-seat turbine powered aircraft while large air carrier aircraft are parked on the southern/transient aircraft apron due to the area and maneuvering space available. All three apron areas accommodate a total of 50 tie-downs and 105 aircraft parking spaces.

The commercial service apron area requirements were determined by referencing the Peak Month/ Average Day (PMAD) activity projections discussed at the beginning of this chapter. Peak hour commercial service operations were broken down into hourly arrivals and compared to the commercial service fleet of aircraft currently operating at and projected to use the airport in the future. Once hourly arrivals by each of the commercial aircraft categories had been established, each aircraft category was assigned a square yardage figure, as well as additional maneuvering area, from which a determination of the amount of space required to adequately accommodate the aircraft on the airport apron during peak hour activity.

The commercial service apron area requirements indicated that there is a demand for approximately 5,100 square yards of space at GCN during peak hour periods of activity. Ultimately, it is indicated that there is a potential demand for approximately 12,200 square yards leaving a total of approximately 17,800 to 24,900 square yards of surplus apron area to be utilized for additional large air carrier, air taxi/commuter and itinerant aircraft throughout the planning period. Based on this analysis, there will continue to be surplus apron area to accommodate additional peak hour commercial service aircraft and, therefore, adequate to accommodate existing and future peak hour commercial service demand levels.

Table 4.17
Commercial Service Aircraft Apron Area Requirements
Grand Canyon National Park Airport

Commercial Service Fleet Operational Activity	Existing	2007	2012	2017	2022
Peak Hour Operations	25	51	52	53	63
Peak Hour Arrivals	13	26	26	28	32
Existing					
Apron Requirements	Single Engine	Multi-Engine	15-Seat Turbine	19-Seat Turbine	Jet/ Turbine
Peak Hr. Apron Demand	1	0	2	9	1
Parking Area per Aircraft (sq. yd.)	140	280	330	330	500
Parking Area Requirements (sq. yd.)	140	0	660	2,970	500
Parking Area + maneuvering Area (20% of sq. yd.)	170	0	790	3,560	600
Total Apron Area Requirement	5,120 Square Yards				
Total Existing Commercial Service Apron Area	30,000 Square Yards				
Apron Area Surplus/ (Deficit)	24,880 Square Yard Surplus				
2007					
Apron Requirements	Single Engine	Multi-Engine	15-Seat Turbine	19-Seat Turbine	Jet/ Turbine
Peak Hr. Apron Demand	1	1	5	18	1
Parking Area per Aircraft (sq. yd.)	140	280	330	330	500
Parking Area Requirements (sq. yd.)	140	280	1,650	5,940	500
Parking Area + maneuvering Area (20% of sq. yd.)	170	340	1,980	7,130	600
Total Apron Area Requirement	10,220 Square Yards				
Total Existing Commercial Service Apron Area	30,000 Square Yards				
Apron Area Surplus/ (Deficit)	19,780 Square Yard Surplus				
2012					
Apron Requirements	Single Engine	Multi-Engine	15-Seat Turbine	19-Seat Turbine	Jet/ Turbine
Peak Hr. Apron Demand	2	1	5	18	1
Parking Area per Aircraft (sq. yd.)	140	280	330	330	500
Parking Area Requirements (sq. yd.)	280	280	1,650	5,940	500
Parking Area + maneuvering Area (20% of sq. yd.)	340	340	1,980	7,130	600
Total Apron Area Requirement	10,390 Square Yards				
Total Existing Commercial Service Apron Area	30,000 Square Yards				
Apron Area Surplus/ (Deficit)	19,610 Square Yard Surplus				
2017					
Apron Requirements	Single Engine	Multi-Engine	15-Seat Turbine	19-Seat Turbine	Jet/ Turbine
Peak Hr. Apron Demand	2	1	5	19	1
Parking Area per Aircraft (sq. yd.)	140	280	330	330	500
Parking Area Requirements (sq. yd.)	280	280	1,650	6,270	500
Parking Area + maneuvering Area (20% of sq. yd.)	340	340	1,980	7,520	600
Total Apron Area Requirement	10,780 Square Yards				
Total Existing Commercial Service Apron Area	30,000 Square Yards				
Apron Area Surplus/ (Deficit)	19,220 Square Yard Surplus				

Note: For planning purposes all square yardage estimates are rounded to the nearest tenth for simplicity.

Source: Commercial Service Fleet Apron Requirements Summary, January 2004.

Table 4.17 (Continued)
Commercial Service Aircraft Apron Area Requirements
Grand Canyon National Park Airport

Commercial Service Fleet Operational Activity	Existing	2007	2012	2017	2022
Peak Hour Operations	25	51	52	53	63
Peak Hour Arrivals	13	26	26	28	32
2022					
Apron Requirements	Single Engine	Multi-Engine	15-Seat Turbine	19-Seat Turbine	Jet/ Turbine
Peak Hr. Apron Demand	3	1	6	21	1
Parking Area per Aircraft (sq. yd.)	140	280	330	330	500
Parking Area Requirements (sq. yd.)	420	280	1,980	6,930	505
Parking Area + maneuvering Area (20% of sq. yd.)	500	340	2,380	8,320	606
Total Apron Area Requirement	12,150 Square Yards				
Total Existing Commercial Service Apron Area	30,000 Square Yards				
Apron Area Surplus/ (Deficit)	17,850 Square Yard Surplus				

Note: For planning purposes all square yardage estimates are rounded to the nearest tenth for simplicity.

Source: Commercial Service Fleet Apron Requirements Summary (Continued), January 2004.

Airside/ Airfield Facility Requirements Summary

Table 4.18 summarizes the airside facility requirements for the Grand Canyon National Park Airport.

Table 4.18
Airside/ Airfield Facility Requirements Summary
Grand Canyon National Park Airport

Facility Type	Recommendations
Runway Facility Requirements	
Runway 3-21	Extend Runway 3-21 (3 End) by 1,001' x 150'
Taxiway Facility Requirements	
Parallel Taxiway 'P'	Extend Taxiway P by 1,001' x 50' to serve proposed 10,000 foot runway length
	Narrow entire length of Taxiway P to 50 foot width
Entrance & Exit/ Connector Taxiways	Narrow Taxiways A through G to 50 foot width
	Ensure taxiway fillets adhere to Design Group III criteria
	Close/ abandon Taxiway A
	Reconfigure Taxiway E to serve as high speed exit taxiway for Runway 3 end
Aircraft Bypass Areas	Construct at ends of Runway 3-21 to accommodate Boeing 737-800 series aircraft
Airport Apron Areas	
Apron 01, Sect. 10	Mill/ rehabilitate this section of southern/ transient apron (PCI 54- Fair)
Airport Geometric Design Standard Requirements	
Runway 21 RPZ	Mitigate Runway 21 RPZ encroachment by Papillion Helicopter Facility
Airfield Technology Enhancements/ Requirements	
Runway Incursions	Contact FAA, Western Pacific Region, to schedule RIAT runway safety/ incursion evaluation.

Source: Airside/ Airfield Facility Requirement Summary, January 2004.

Commercial Service Terminal Facility Requirements

A detailed passenger terminal building facility requirements program, estimating the spatial requirements needed to accommodate passenger demand for the planning period, was developed during the completion of the GCN facility requirements analysis. The passenger terminal area requirements are organized into seven separate categories including airlines services, concessionaire services, security services, public circulation areas, building public services, terminal administration/ operations and structural/ mechanical. The components within each of these categories will be further identified as being public versus non-public and rentable versus non-rentable.

Aside from calculating the square footage requirements to accommodate peak hour passenger demand at GCN, this analysis will also include terminal building siting considerations, as well as a discussion of alternative terminal building concepts. Future alternatives to be considered in the next section of the report will include a full range of options beginning with a no-action alternative, the consideration of alternative new site locations, and an analysis of alternative design concepts as discussed in the following pages.

Passenger Terminal Building Siting Considerations

A modern renovation or expansion of the existing GCN passenger terminal building may not be a feasible option given its physical constraints with regard to accommodating peak hour passenger demand. Additionally, the current facility may not allow the flexibility for expansion either horizontally or vertically. Therefore, it may be necessary to consider planning for the location of a future passenger terminal building that will be permanently fixed in its future location.

With the development of a new passenger terminal facility comes considerations that will ultimately affect the siting location of the terminal building. The following discussion highlights these important considerations and serves as an introduction to many of the design options that will be addressed in the alternatives chapter to follow.

- *Runway Configuration*: Terminal building siting should minimize aircraft taxiing distances and times, as well as the number of runway crossings required between the aircraft parking apron and runway. At GCN, the passenger terminal building would ideally be located centrally with respect to mid-point of Runway 3-21.

- *Surface Transportation Access*: As air transportation demand at an airport increases, so too does various modes of ground transportation. The siting of a new terminal facility should allow for providing the most direct and shortest route between the terminal building and parking facilities, as well as the main surface transportation access to and from the airport. At GCN, the public auto parking facilities, as well as the terminal ground access routes are recommended to be no more than 500 to 1,000 feet in distance from the entrance to the passenger terminal building.

- *Expansion Potential*: Potential expansion beyond the long-term facility requirements should be taken into consideration. Additional space allowances as a result of growth beyond forecasted needs is recommended to be incorporated into the ultimate terminal building concept. Likewise, the terminal building is recommended to be sited in a location allowing horizontal and vertical expansion.

- *FAA Design Criteria*: Ultimate terminal facilities should be located at minimum safe separation distances from runway centerlines, taxiways and taxilanes, aircraft maneuvering areas, and airport property boundaries as specified in pertinent Federal Aviation Regulations (FAR) and FAA Advisory Circulars (AC). Additionally, planned terminal facilities must be sited in accordance with FAR Part 77 so as to not create an airspace hazard for arriving and departing.

- *Existing and Planned Facilities*: The siting of a future passenger terminal facility shall not infringe on existing or planned facilities at the airport such as ATCT line-of-sight, NAVAIDS or additional airport structures or utilities.

- *Terrain/Topography*: Development on relatively flat, stable, sandy or silty soil is recommended to reduce grading and earth fill quantities thereby reducing development costs.

- *Environmental Impacts*: When an airport terminal development project results in an increase of 25 percent passenger/ facility capacity, facility siting must be analyzed and weighted in order to determine whether the development results in any significant environmental impact. An Environmental Assessment (EA) is recommended prior to the siting and development of a passenger terminal building at GCN.

Passenger Terminal Building Concepts

The primary objective of an overall terminal building plan concept is to achieve an acceptable balance between passenger convenience, facility operational efficiency, facility investment, as well as aesthetics. More importantly, a well conceived terminal area plan should allow passengers to transition from the public or private mode of surface transportation to the air transportation mode at a minimum of inconvenience and maximum time efficiency. Lastly, the ultimate passenger terminal building plan should be developed and constructed within allowable funding levels taking into consideration not only the capital investment costs but also operational and maintenance costs.

The following discussion concentrates on and serves as an introduction to the basic concepts of terminal arrangement, terminal building design concepts, as well as single level versus multi-level terminal design concepts. These design concepts and alternative development options will be assessed in the following Chapter 5, *Airport Alternatives.*

Centralized and Unit Terminal Buildings
Two basic concepts of terminal building arrangement are the centralized terminal and the unit terminal concept. In a centralized terminal building layout all passengers, baggage, and terminal processes occur inside of one building. This terminal building arrangement is common at most airports particularly at airport experiencing less active passenger activity. A centralized terminal building concept represents a compact environment that does not experience the costs and inefficiency associated with transferring passengers and baggage between multiple buildings. Given this characteristic, a centralized terminal concept does not experience the operational and maintenance costs associated with multiple terminal buildings.

The unit terminal concept includes passenger processing terminal activities taking place in multiple building being occupied by multiple airlines. This terminal arrangement is common at medium and large-hub airports experiencing greater than one million passenger enplanements. As a result of the physical characteristics associated with the unit terminal concept, operational and maintenance costs are high in addition to efficiency issues often associated with the unit terminal concept.

A centralized terminal building arrangement, given its physical, cost and efficiency characteristics, is recommended for inclusion into an ultimate terminal building design concept for GCN.

Terminal Building Design Concept
There are five terminal building design concept categories that include the simple, linear, pier, satellite and transporter terminal building concepts. For purposes of this analysis, the simple, linear, pier and transporter design concepts will be discussed as options for future terminal development at GCN.

- *Simple Terminal Concept*: The simple terminal building consists of a single common waiting and ticketing area with access being provided directly to the aircraft apron where there is space for approximately three to six commercial service/ air carrier aircraft. Additional characteristics that define a simple terminal concept include a single level structure with three to four aircraft gates providing access to aircraft by walking across the apron. GCN's current terminal building is classified as a simple terminal design. As passenger demand surpasses 200,000 enplanements, as is the case here, linear and pier terminal concepts are recommended to replace the existing terminal building.

- *Linear Terminal Concept*: This terminal design accommodates the desired number of aircraft parking spaces and gates along the face of the building. Additionally, concourses or connectors (enclosed or external), link the terminal functions with the aircraft gate positions and provides ease of access and short walking distances. Expansion is accomplished by linear extensions of an existing structure of by developing additional linear terminal units linked by concourses or connectors. Passenger activity between 200,000 and one million enplanements represent a threshold at which a linear concept is appropriate to accommodate demand. Additionally, passenger demand

levels up to one million enplanements generally require a linear terminal design concept that can accommodate six (6) to eight (8) gates (Type A) designed to service Category C aircraft.

- *Pier Terminal Concept*: This terminal design concept provides aircraft interface along piers that extend from the main terminal building internal/external concourse or connector. Aircraft park around the axis of the pier extension in a parallel or perpendicular fashion. Each pier extension is equipped with a row of aircraft gate positions on both sides while the center portion of the pier serves as a passenger circulation area. Access to the main terminal area is provided at the root of the pier extension. Generally, the pier terminal design concept is warranted when passenger activity is at least 500,000 enplanements and exceeds one million enplaned passengers.

- *Transporter Terminal Design Concept:* Aircraft servicing functions and passenger boarding are located apart from the main terminal concourse. Vehicular transport provides connection to the terminal building environment for enplaned and deplaned passengers. Advantages of the transporter design concept include flexibility in additional aircraft parking, increased space for aircraft maneuvering and reduced walking distances for passengers. Given unique passenger and operational characteristics at GCN, a transporter design element to the overall terminal building design plan may be considered.

Given the uniqueness of operational and passenger demand characteristics of GCN, the ultimate passenger terminal building concept may need to incorporate combinations or variations of the linear and pier terminal design concept due to unanticipated operational or passengers activity changes that could be experienced at the airport during the new terminal building's lifespan. This, again, will be discussed further in Chapter 5, *Airport Alternatives.*

Single Level/Multi-Level Terminal Designs
Volume of passenger activity, as well as aircraft operational demand, are the primary influences behind the decision of incorporating a single or multi-level terminal building design to process passengers at an airport. This section includes a brief discussion of both terminal variations.

- *Single Level Terminal*: The single level terminal allows passenger processing and baggage operations to occur on the same level as the airport apron making this design simple and economical. The single level terminal design concept is the preferred design at a majority of small and non-hub airports.

- *Multi-Level Terminal*: In this design concept enplaning and deplaning passengers are vertically separated. Enplaning passengers are processed in the upper level while deplaning passengers are processed on the lower level of the terminal. Airport passenger activity exceeding 500,000 annual enplanements necessitates the need to investigate this more than one level terminal building design feature. The principal advantage of a multi-level

terminal building includes less congestion resulting from the separation of enplaning and deplaning passengers. However, the principal disadvantages of this design concept are the monetary resources needed for initial investment, as well as higher than average maintenance and operational costs. Crucial design considerations of a multi-level terminal building include whether to have single or multiple tiers for the pier fingers or connector concourses providing access to arriving and departing aircraft.

It is recommended that the future passenger terminal building development for GCN take into consideration the multi-level terminal building design concept as an alternative to accommodating enplaning and deplaning passenger demand throughout the 20 year planning period and beyond.

Passenger Terminal Building Space and Facilities

This section will concentrate primarily on guidance for the necessary spatial requirements for the future commercial service passenger terminal building at the Grand Canyon National Park Airport. It is important to note that this spatial analysis was based on the estimation that all commercial service fixed wing passenger enplanements will be processed exclusively in the future passenger terminal building. Furthermore, this spatial analysis takes into account space allowances that may occur as a result of growth beyond forecasted needs of the community in which the future terminal building is expected to serve. Additionally, at such time that new passenger terminal building development is imminent, the spatial needs indicated in this section will most likely require modification and adjustments based on the actual demand at that future time. Table 4.19 summarizes the passenger terminal building spatial requirements for the Grand Canyon National Park Airport.

Based on the passenger terminal building spatial requirement calculations, the existing GCN terminal building is not adequate to accommodate existing and forecast passenger demand and alternative improvement options should be assessed. It is recommended that the airport sponsor invest in conducting a terminal building development plan which calls for the construction of a new 60,000 square foot passenger terminal building in a location to be determined during the Airport Alternatives analysis (Chapter No. 5) of this master plan update.

Table 4.19
Commercial Service Passenger Terminal Building Spatial Requirements
Grand Canyon National Park Airport

Commercial Service PMAD Peak Hour Passenger Demand	Existing 117	2007 219	2012 235	2017 252	2022 279
Airline Services					
Aircraft Gate Positions	-	6	6	7	8
Air Carrier/ Air Tour Operations Area	-	13,000 sq. ft.	13,000 sq. ft.	14,000 sq. ft.	16,000 sq. ft.
Airline Ticket Counters/ Ticketing Lobby	1,612 sq. ft.	3,000 sq. ft.	3,200 sq. ft.	3,500 sq. ft.	4,000 sq. ft.
Baggage Claim Total Area	972 sq. ft.	1,205 sq. ft.	1,345 sq. ft.	1,495 sq. ft.	1,655 sq. ft.
Baggage Claim Device	-	880 sq. ft.	1,020 sq. ft.	1,170 sq. ft.	1,330 sq. ft.
Baggage Claim Lobby	-	325 sq. ft.	325 sq. ft.	325 sq. ft.	325 sq. ft.
Departure Lounge(s) Area	-	5,375 sq. ft.	5,375 sq. ft.	6,050 sq. ft.	6,725 sq. ft.
Departure Lounge Seating Capacity	-	269	269	303	336
Airline Services Requirements	**2,584 sq. ft.**	**23,785 sq. ft.**	**24,265 sq. ft.**	**26,540 sq. ft.**	**30,035 sq. ft.**
Building Public Services					
Medical Aid Services	150 sq. ft.	150 sq. ft.	150 sq. ft.	150 sq. ft.	150 sq. ft.
Public Restrooms	668 sq. ft.	1,500 sq. ft.	1,500 sq. ft.	1,500 sq. ft.	1,500 sq. ft.
Public Telephone Area	-	40 sq. ft.	50 sq. ft.	50 sq. ft.	55 sq. ft.
Building Public Services Requirements	**818 sq. ft.**	**1,690 sq. ft.**	**1,700 sq. ft.**	**1,700 sq. ft.**	**1,705 sq. ft.**
Concessionaire Services					
Food and Beverage Services	470 sq. ft.	9,100 sq. ft.	9,700 sq. ft.	10,450 sq. ft.	11,530 sq. ft.
Gift and Apparel Shops		275 sq. ft.	290 sq. ft.	320 sq. ft.	350 sq. ft.
Rental Car Counter Space	56 sq. ft.	150 sq. ft.	160 sq. ft.	170 sq. ft.	190 sq. ft.
Vending Machine Facilities	-	50 sq. ft.	50 sq. ft.	50 sq. ft.	50 sq. ft.
Concessionaire Services Requirements	**526 sq. ft.**	**9,525 sq. ft.**	**10,200 sq. ft.**	**10,990 sq. ft.**	**12,120 sq. ft.**
Public Circulation Areas					
Passenger Waiting Lobby	990 sq. ft.	2,800 sq. ft.	3,000 sq. ft.	3,200 sq. ft.	3,500 sq. ft.
Passenger Seating	-	110	118	126	175
Open Corridor Space	2,026 sq. ft.	2,250 sq. ft.	2,500 sq. ft.	2,750 sq. ft.	3,050 sq. ft.
Public Circulation Area Requirements	**3,016 sq. ft.**	**5,050 sq. ft.**	**5,500 sq. ft.**	**5,950 sq. ft.**	**6,550 sq. ft.**
Security Services					
Security Inspection Stations	-	1- 150 sq. ft.	1- 150 sq. ft.	1- 150 sq. ft.	1- 150 sq. ft.
Structural/ Mechanical Services					
Building Maintenance and Storage Area	413 sq. ft.	800 sq. ft.	860 sq. ft.	920 sq. ft.	1,010 sq. ft.
Building Mechanical Systems	-	3,900 sq. ft.	4,230 sq. ft.	4,540 sq. ft	5,020 sq. ft.
Building Structure	424 sq. ft.	1,640 sq. ft.	1,760 sq. ft.	1,890 sq. ft.	2,090 sq. ft.
Structural/ Mechanical Area Requirements	**837 sq. ft.**	**6,340 sq. ft.**	**6,850 sq. ft.**	**7,350 sq. ft.**	**8,120 sq. ft.**
Terminal Administration/ Operations Area					
Airport Mgt./ Operations/ Admin. Area	594 sq. ft	1,000 sq. ft.	1,000 sq. ft.	1,000 sq. ft.	1,000 sq. ft.
Total Passenger Terminal Building Components Spatial Requirements					
Passenger Terminal Building Area	**8,486 sq. ft.**	**47,540 sq. ft.**	**49,665 sq. ft.**	**53,680 sq. ft.**	**59,680 sq. ft.**

Source: Commercial Service Passenger Terminal Building Requirements Summary, January 2004.

Table 4.19 (Continued)
Commercial Service Passenger Terminal Building Spatial Requirements
Grand Canyon National Park Airport

Notes:
1. Gate positions, ticket counters and ticketing area calculations based on passenger and fleet operational activity, as well passenger seating accommodation provided by commercial service/ air tour operators.
2. Air carrier/ air tour operations area(s) assumes 500 square feet/ peak hour aircraft departure.
3. Baggage claim areas represents spatial requirements for a flatbed- manual feed baggage claim facility at small hub airports.
4. Departure lounge area represents 75-85 percent aircraft boarding factors for 19 seat and 161-200 seat commercial service aircraft. Seating totals equal 20 square feet per passenger seat.
5. Medical facilities are base on existing conditions at GCN and assumes 150 square feet of space is required.
6. Public restroom spatial needs assumes 1,500 square feet of space/ 500 peak hour passengers.
7. Public telephone spatial requirements assumes 100 square feet/ one million enplanements.
8. Food and beverage service are needs assumes 35 square feet/ patron seat.
9. Gift and apparel shop space needs assumes 650 square feet/ one million enplanements.
10. Rental car counter space assumes 350 square feet/ one million enplanements.
11. Vending machine space assumes a minimum of 50 square feet of space/ one million passenger enplanements.
12. Passenger waiting lobby area and seating capacity is sized for 25 percent of peak hour passengers plus visitors.
13. Number of security inspection stations and corresponding area assumes one walk-through weapons detector and one x-ray device with a capacity of 500 to 600 persons per hour and requiring an area of 150 square feet.
14. Building mechanical systems and building structure space requirements assumes 12 percent and 5 percent of gross terminal building space, respectively.
15. Airport management, operations and administrative offices assumes a minimum of 1,000 square feet of space.

Source: Commercial Service Passenger Terminal Building Requirements Summary (Continued), January 2004.

Airport Access and Terminal Area Roadways

As aircraft operational and passenger enplanement activity at GCN increases throughout the planning period, airport-related traffic volumes will increase accordingly on airport access and terminal area roadways including Arizona Highway 64. GCN's airport access and terminal area roadway system were discussed in Chapter II, *Airport Inventory*.

Based on current local vehicular traffic demand at GCN, the airport access and terminal area roadway system provides adequate capacity and accommodates peak hour traffic demand during peak tourist season (August). It is recommended, however, that a traffic impact analysis be conducted to determine the actual capacity of the airport terminal access roadways to accommodate ultimate traffic conditions and to determine if there are inadequacies with the existing access system as it relates to airport surface traffic flow conditions. Additionally, an ultimate traffic impact analysis is recommended to determine appropriate vehicular traffic capacity and flow conditions at such time that a new passenger terminal building and corresponding public parking facilities are constructed.

Terminal Building Curbfront Facilities

The terminal building curb frontage facilities are utilized specifically for loading and unloading passengers and baggage. The length of curb that is required to accommodate demand depends on the mix of motor vehicle types and expected curb dwell time.

Existing Conditions

The existing conditions of the current GCN terminal building curbside facilities includes 315 linear feet of curb frontage and accommodates five marked parking spaces for airport operations and local law enforcement personnel equaling approximately 125 feet of curb frontage. The remaining 190 feet of curb frontage can accommodate three passenger buses, as well as one 14-passenger shuttle bus or cargo/passenger van. The current GCN passenger terminal building is also served by two vehicle traffic lanes. One lane is utilized

as the curb/maneuvering lane, while the second outside lane is utilized as a through lane for terminal area access and circulation.

Ultimate Curbfront Facility Demand
Ultimate curbfront demand for GCN was determined by considering the ultimate peak hour passenger enplanements, anticipated vehicular traffic mix and assumed curb dwell time for enplaning and deplaning passengers. At GCN, 50 percent of the peak hour passengers enplanements are assumed to arrive at the airport by passenger bus while the remaining enplaned passengers are assumed to have arrived by other modes of transportation such as private automobile, etc. Additionally, consideration was given to the seating capacity of the passenger buses providing service to and from GCN. This estimate of available passenger bus seating was then compared to the enplaned passengers requiring bus service to and from the Grand Canyon Village. The result of this comparison yielded an hourly demand for passenger buses directly utilizing curb frontage at the passenger terminal building.

Upon determining the hourly bus activity at the terminal building, the overall length requirements for passenger buses was determined for purposes of curbside parking and maneuvering. Passenger buses are estimated to require approximately 50 linear feet of curb slot length.

Lastly, curb dwell time for passenger buses at the terminal building was considered. For this analysis, it was assumed that enplaning passengers would require approximately two minutes and 30 seconds to evacuate a bus at its full capacity. This assumption also considered the fact that as a bus is unloaded there would be additional passenger demand (deplaned passengers) located at the curbside to disembark from the airport on the same bus. For calculation purposes, given the fact that passenger characteristics at GCN purport to show that little or no carryon luggage accompanies passengers on the bus, it was assumed that approximately two minutes and 30 seconds would also be required to load a bus to its capacity. Upon comparing curb dwell time with parking requirements for passenger buses, coupled with estimated passenger activity taking place at the Airport, a projected curb frontage demand length was calculated. Table 4.20 summarizes the passenger terminal building linear curbside frontage requirements for the Grand Canyon National Park Airport.

The terminal building curbside facility calculations indicate that the existing terminal building's curbside frontage of 315 linear feet is adequate for current peak hour activity needs. However, based on projected airport operational and passenger demands, the current terminal frontage accommodations are inadequate for future needs and will require an additional 355 linear feet of curb frontage totaling 670 linear feet of curbside access for the ultimate passenger terminal building at GCN.

Table 4.20
Passenger Terminal Building Curbside Frontage Requirements
Grand Canyon National Park Airport

Demand Factors	Existing	2007	2012	2017	2022
Peak Hour Passenger Demand	117	219	235	252	279
50 Percent of Peak Hour Passenger Demand	59	110	118	126	140
Passenger Bus Seating Capacity	52 seats				
Ratio of Demand to Hourly Bus Seating Capacity	1.1	2.1	2.2	2.4	2.7
Passenger Bus Slot Length Requirement	50 feet				
Enplaning Passenger Curb Dwell Time (Minutes)	2.5	2.5	2.5	2.5	2.5
Deplaning Passenger Curb Dwell Time (Minutes)	2.5	2.5	2.5	2.5	2.5
Total Curb Dwell Time	5 minutes				
Total Curbside Frontage Requirements (Linear Feet)	280	530	560	610	670
Terminal Building Curbfront Linear Foot Demand Surplus/ (Deficit)	35	(215)	(245)	(295)	(355)

Note: Curbside frontage linear requirement projections rounded to the nearest tenth.
Source: Curbside Frontage Requirements Summary, January 2004.

Passenger Terminal Building Public Auto Parking Facilities

Approximately 40 to 85 percent of enplaning passengers arrive at commercial service airports in a private vehicle. Given this, in addition to the operational and passenger characteristics at GCN, adequate public parking facilities are essential to prudent passenger terminal building design. This commercial service auto parking facility analysis will include recommendations regarding ultimate short-term and long-term public parking requirements, rental car space requirements, employee and tenant parking space needs, public transit and bus parking, as well as auto parking space requirements for individuals with disabilities.

Existing Parking Facilities

The existing public auto parking facilities for GCN is described in Chapter II, Page 2-17, Table 2.11. Currently, the Airport accommodates 125 passenger vehicle parking spaces totaling approximately 41,250 square feet of parking area, including maneuvering space to minimize the time necessary to acquire a parking spot. These 125 parking spaces are located immediately adjacent to the passenger terminal building and share additional space with public transit/bus parking, rental car parking and employee/tenant parking area.

The methodology utilized to determine future commercial service public auto parking space requirements is primarily based on recommendation as referenced within FAA AC 150/ 5360-13, *Planning and Design Guidelines for Airport Terminal Facilities.* For GCN, a ratio of 1.5 parking spaces per peak hour passenger, based on the Peak Month/Average Day (PMAD) forecasts, was determined to provide the most likely scenario for parking space requirements during peak periods of passenger and airport operational activity. A square footage requirement of 330 square feet per passenger vehicle, which includes maneuvering area, will be utilized to determine the overall area necessary to accommodate future parking demands. This was based on current industry design standards and practices. It should be noted that future commercial service terminal building parking

requirements will be based on passenger activity generated by fixed wing aircraft. Rotorwing passenger activity at GCN is largely conducted from private facilities located apart from the main terminal area complex with parking facilities owned and operated by the air tour service provider.

Short-Term and Long-Term Public Auto Parking
Short-term and long-term auto parking areas are recommended to be segregated once annual passenger activity surpasses 150,000 to 200,000 passenger enplanements. Short-term parking is identified as anything resulting in less than three hours of parking time and results in approximately 20 to 30 percent of total parking lot usage. The generally accepted definition of long-term parking is anything greater than three hours and generally results in parking lot users utilizing 70 to 80 percent of the available parking spaces. However, at GCN, given the uniqueness of passenger and operational activity of the Airport, it is estimated that approximately 85 percent of the parking lot usage is short-term in nature with the remaining 15 percent usage being long-term. Table 4.21 summarizes the existing and ultimate short-term and long-term commercial service parking requirements for the Grand Canyon Nation Park Airport.

The commercial service public auto parking facility analysis concludes that existing peak hour passenger demand surpasses available capacity of the parking facilities resulting in a current deficit of 51 vehicle spaces. Ultimate enplaning passenger demand is expected to require the need for an additional 294 public parking spaces that is equivalent to approximately 97,000 square feet. Regarding projected short and long-term parking space needs, the analysis concluded that of the 419 public parking spaces to be made available at GCN, 356 will be designated short-term parking while the remaining 63 spaces will be available for long-term parking use.

Table 4.21
Short Term & Long-Term Parking Area Requirements
Grand Canyon National Park Airport

Total Passenger Terminal Building Parking Needs

Year	Peak Hour Demand	Parking Spaces/ Peak Hour Passenger	Square Footage Demand/ Parking Space (sq. ft.)	Total Parking Demand		Parking Demand Surplus/ (Deficit)	
				Spaces	Sq. Ft.	Spaces	Sq. Ft.
Existing	117			176	58,030	(51)	(16,780)
2007	219			329	108,570	(204)	(67,320)
2012	235	1.5	330 sq. ft.	352	116,160	(222)	(74,910)
2017	252			378	124,740	(253)	(83,490)
2022	279			419	138,270	(294)	(97,020)

Short-Term Passenger Terminal Parking Needs

Year	Total Parking Demand	Short-Term Lot Demand	Square Footage Demand/ Parking Space (sq. ft.)	Total Short-Term Parking Demand	
				Spaces	Sq. Ft.
Existing	176			150	49,500
2007	329			280	92,400
2012	352	85%	330 sq. ft.	299	98,670
2017	378			321	105,930
2022	419			356	117,480

Long-Term Passenger Terminal Parking Needs

Year	Total Parking Demand	Long-Term Lot Demand	Square Footage Demand/ Parking Space (sq. ft.)	Total Long-Term Parking Demand	
				Spaces	Sq. Ft.
Existing	176			26	8,580
2007	329			49	16,170
2012	352	15%	330 sq. ft.	53	17,490
2017	378			57	18,810
2022	419			63	20,790

Source: Short-term & Long-Term Parking Requirements Summary, January 2004.

Employee and Tenant Parking Facilities
Currently, there are approximately 30 parking spaces provided for employee and airport tenants. Employees and tenants working for business which occupy space in the passenger terminal building, as well as the FBO, Grand Canyon Airlines, park in the existing public parking facility.

Due to the lack of a consistent relationship between the number of airport employees and enplaned passengers, methodologies to compare similarities between the two variables for purposes of calculating projected parking facility needs has not been established. As airport passenger and operational activity at GCN increase, it is plausible to assume that the number of employees will increase based on the companies' need to supply additional workers to meet the public demand for aviation and air tour services at the airport. Accordingly, 15 percent of the projected public parking space requirements will be allocated for airport and tenant parking needs. Table 4.22 summarizes the existing and ultimate employee and airport tenant parking requirements for the GCN.

Table 4.22
Employee/ Airport Tenant Terminal Building Parking Area Requirements
Grand Canyon National Park Airport

Year	Total Parking Demand	Ratio of Employee Parking to Public Parking	Square Footage Demand/ Parking Space (sq. ft.)	Employee/ Tenant Parking Demand		Parking Demand Surplus/ (Deficit)	
				Spaces	Sq. Ft.	Spaces	Sq. Ft.
Existing	176			26	8,580	4	1,320
2007	329			49	16,170	(19)	(6,270)
2012	352	15%	330 sq. ft.	53	17,490	(23)	(7,590)
2017	378			57	18,810	(27)	(8,910)
2022	419			63	20,790	(33)	(10,890)

Source: Employee/ Airport Tenant Parking Requirements Summary, January 2004.

During Phase I of airport development (2007), the employee/airport tenant parking will require the addition of 19 parking spaces occupying approximately 6,300 square feet. Ultimate employee/tenant parking demand is expected to increase to 63 parking spaces requiring the need for approximately 20,800 square feet of parking area.

Rental Car Parking Facilities

The GCN public parking facilities accommodate 20 rental car parking spaces. Enterprise Rental Car, which is no longer providing exclusive rental car service at the Airport, was the sole rental company at GCN that utilized these parking spaces. Since the time that Enterprise chose to cease operations at GCN, the rental car spaces have been unoccupied.

Although a rental car company is not currently conducting business operations at GCN, history dictates that there is a demand for potential rental car facilities and parking space at the airport. Given the unique nature of passenger activity at GCN coupled with the fact that a method for determining rental car space requirements, as referenced in FAA AC 150/ 5360-13, does not necessarily apply to the operational and passenger levels and characteristics experienced at GCN, FAA AC 150/5360-9, *Planning and Design of Airport Terminal Facilities at Non-hub Locations*, was consulted. Although GCN is classified as a small hub airport, AC 150/ 5360-9 provided meaningful information on rental car facility requirements that are similar to the existing rental car facility conditions at GCN. Accordingly, information derived from this advisory circular was utilized to determine the future rental car parking facility needs at GCN throughout the planning period.

A minimum of 10 rental car parking spaces is recommended for each rental agency occupying counter space in the passenger terminal building. These 10 parking spaces are also recommended to take into account the necessary space requirements for ready and return spaces, as well as parking spaces used specifically for vehicle storage. For determining ultimate rental car parking area requirements, this analysis assumed that four of the necessary parking spaces will be utilized for ready and return use, while the remaining six spaces will be used for vehicle storage. Additionally, ready and return parking area will require 330 square feet per space and storage spaces will require approximately 220 square feet of area per space.

It is recommended that of the 20 existing rental car parking spaces, at such time that a rental car agency(s) initiates service at GCN, eight of the spaces be configured for ready and return use and be marked to accommodate 2,640 square feet of space. The remaining 12 spaces are recommended to be designated as storage spaces and marked to accommodate 2,640 square feet. For ultimate planning considerations, in the likely event that additional rental car agencies establish service at GCN, 10 rental car spaces are to be provided for each company in accordance with the recommendations stated above.

Public Transportation/ Passenger Bus Parking Facilities

Public transportation at GCN is an integral part of the Grand Canyon experience in that as passengers arrive on particular air tour and commercial service operators they are transferred to waiting buses in order to make the journey to the South Rim and Grand Canyon Village. Combined, passenger bus parking spaces located at the passenger terminal building, as well as adjacent to the southern transient aircraft apron, total 34 spaces occupying approximately 23,100 square feet of parking area in the main passenger terminal building parking area.

Parking facilities designed to accommodate professionally operated buses and passenger vans are important to GCN in that an overwhelming majority of enplaning and deplaning passengers will utilize one or both of these modes of public transportation services at the airport. Passenger vans, like private vehicles, can be accommodated with approximately 330 square feet of parking space and maneuvering area while a passenger bus requires approximately 680 square feet of parking and maneuvering area. Given this fact, it is important to establish a separate parking facility specifically for passenger buses in close proximity to the passenger terminal building.

In calculating the ultimate passenger bus parking facilities at GCN, recommendations regarding public transportation parking facility demand as referenced within FAA AC 150/ 5360-13 were consulted. For professional public modes of transportation space for 160 vehicles per acre is recommended. Given the demand for passenger bus services at GCN, future parking requirements will be calculated by recommending that one acre of space be set aside exclusively for bus parking. Additionally, parking space and maneuvering area will set aside for passenger vans in the event that additional parking space for these vehicles is needed.

Ultimate GCN passenger bus parking facility requirements are recommended to include one acre of land designed to accommodate 64 vehicles at 680 square feet per parking space. This total bus parking area will total 43,560 square feet. In order to accommodate passenger vans in this parking area, 15 percent of the total area required for bus parking was included into the total space requirement necessitating the need for an additional 6,530 square feet designed to accommodate 18 passenger van spaces at 360 square feet per parking space. Future public transportation/passenger bus parking facilities are recommended to accommodate a total of 82 parking spaces and occupy an area of 50,090 square feet.

Individuals with Disabilities (ADA/ ADAAG) Parking Facilities
The American with Disabilities Act (ADA), enacted in 1990, prohibits discrimination on the basis of disability in state and local government services and transportation (Title II) and public accommodations (Title III). In 1991 the American with Disabilities Act Accessibility Guidelines (ADAAG) was enacted to ensure that facilities and vehicles protected by the law are accessible to individuals with disabilities in terms of transportation and associated needs. Title II of the law makes all provisions of the law applicable to facilities administered by governmental entities (i.e. airports). Additionally, ADA subjects airports to regulations administered by the Department of Transportation (DOT), as well as the ADAAG when considering alteration, renovation, or capital improvements at airports.

With regards to future ADA/ADAAG parking requirements at GCN, according to ADAAG and DOT guidelines, one out of every 25 parking spaces must meet accessibility standards for up to 500 auto parking spaces. Additionally, one of every eight accessible parking spaces must be van accessible. Therefore, for square footage purposes, 350 square feet per parking space will be utilized to determine future ADA/ ADAAG parking needs. Existing ADA/ ADAAG parking accommodations at GCN include six accessible parking spaces. Table 4.23 summarizes the existing and ultimate ADA/ADAAG airport parking requirements for the Grand Canyon Nation Park Airport.

Table 4.23
ADA/ ADAAG Terminal Building Parking Area Requirements
Grand Canyon National Park Airport

Year	Total Parking Demand	Ratio of ADA Parking Spaces to Public Parking Spaces	ADA/ ADAAG Square Footage Demand/ Parking Space (sq. ft.)	ADA/ ADAAG Parking Space Demand		ADA/ ADAAG Parking Demand Surplus/ (Deficit)	
				Spaces	Sq. Ft.	Spaces	Sq. Ft.
Existing	176			7	2,450	(1)	(350)
2007	329			13	4,550	(7)	(2,450)
2012	352	1:25	350 sq. ft.	14	4,900	(8)	(2,800)
2017	378			15	5,250	(9)	(3,150)
2022	419			17	5,950	(11)	(3,850)

Note: Based on ADA/ ADAAG criteria, the necessary required number of ultimate van accessible parking spaces is two (2) parking spaces totaling approximately 700 square feet of the total ADA/ ADAAG parking space demand.
Source: ADA/ ADAAG Parking Requirements Summary, January 2004.

Air Cargo Facility Requirements

Absent existing or future demand for air cargo operations or facilities at the Grand Canyon National Park Airport, air cargo facility requirements will not be determined as part of the terminal area facility requirements for this master plan update.

Support Facility Requirements

Ancillary or support facilities at GCN play a pivotal role in the continued efficient and safe operation of the airport. The sizing, capacity, and phasing of capital improvements to these facilities must be flexible and reasonable to accommodate the dynamic growth in

passenger traffic and aviation activity at the airport. The facility requirements for the support facilities at GCN, along with the corresponding recommendations for each, were determined based on general planning parameters designed to adhere to and maintain minimum facility standards throughout the planning period.

Support facilities at GCN include:

- Airport Fueling/ Fuel Farm Facilities
- Aircraft Rescue and Firefighting (ARFF)
- Snow Removal Equipment (SRE) Facilities
- Air Traffic Control Tower (ATCT)

Airport Fueling/Fuel Farm Facilities

The airport fueling facilities, storage capacities, and capabilities at GCN being administered and conducted by Grand Canyon Airlines (GCA), were discussed in Chapter II, Tables 2.15 and 2.16. The total airport fuel storage capacity, including Jet A, 100LL, diesel fuel and unleaded fuel, is 48,000 gallons. 40,000 gallons of the overall fuel storage capacity includes Jet A fuel and 100LL avgas. Additionally, the majority of the fueling operations that take place at GCN are conducted by the use of fuel trucks which includes three Jet A, as well as two 100LL fueling trucks. The total fuel truck capacity at GCN is approximately 12,400 gallons.

Following interviews with ADOT, Aeronautics Division and GCA personnel it was determined that the fueling facility's storage capacity and capabilities at GCN including Jet A, 100LL avgas and fuel truck capacity are adequate to accommodate the existing and ultimate peak hour aviation demand, including reserves, at the Airport throughout the 20-year planning period. Additionally, it is recommended that the airport Sponsor ensure the fueling truck parking area abides by regulations set forth by the Environmental Protection Agency's (EPA) Spill Prevention and Countermeasure Program and that the fuel containment systems are adequate for continued safe fueling operations.

Lastly, the Airport is recommended to consider the installation of a vehicle wash rack facility for fuel tracks, as well as buses, that is environmentally acceptable and capable of accommodating peak periods of vehicular and fueling activity.

Aircraft Rescue and Firefighting (ARFF)

The primary objective of ARFF service is to save lives by minimizing the affects of an aircraft accident or incident. This analysis will determine the facility, vehicle/equipment and response time requirements for the GCN AFRR services.

Current GCN ARFF facilities, equipment and personnel status were discussed in Chapter II, Table 2.12. GCN ARFF emergency response capabilities are classified as Index A[1] while being capable of responding to emergencies as an Index B facility[2]. GCN ARFF is located northeast of the passenger terminal building and is housed in a 2,150 metal framed structure where seven (7) certified firefighting personnel are stationed.

[1] Index A- Aircraft less than 90 feet in length (DHC-6-300, Beech 99, Dornier 228 and 328)
[2] Index B- Aircraft 90-126 feet in length (Boeing 727/ 737 series and MD-80 series aircraft)

ARFF Facilities
The current ARFF facility is inadequate from a spatial standpoint to accommodate aviation demand levels during the 20-year planning horizon. Currently, plans are under way to begin construction of a new $3.5 million ARFF/maintenance/snow removal and equipment (SRE) building capable of accommodating four ARFF vehicles, in addition to another four SRE/ maintenance/snow removal vehicles.

ARFF Equipment/Vehicles
14 CFR, FAR Part 139, *Subpart D- Operations*, paragraphs 139.315 and 139.317 establishes a system of classifying an airport into an emergency response capability index which is based on the longest air carrier aircraft conducting five or more average daily departures at the airport. Each response capability index has a corresponding ARFF equipment and vehicle requirement to service a specific category of airport. Table 4.24 contains the Index A and B ARFF equipment/vehicle requirements for Grand Canyon National Park Airport.

Table 4.24
Aircraft Rescue & Firefighting (ARFF) Equipment and Vehicle Requirement Summary
Grand Canyon National Park Airport

FAR Part 139.315 & 139.317 ARFF Equipment Requirements

Airport Index	Length of Aircraft (ft.)	Number of Vehicles	Extinguishing Agents (Quantity)		
			Dry Chemical	Water	AFFF
Index A	Under 90 ft.	One (1)	500 or 450 lbs.	Commensurate quantity of AFFF and water to total 100 gallons	
Index B	90-126 ft.	Two (2)	500 lbs.	Commensurate quantity of AFFF and water to total 1,500 gallons	

GCN ARFF Vehicle/ Equipment Inventory

Airport Index	Length of Aircraft (ft.)	Number of Vehicles	Extinguishing Agents (Quantity)*		
			Dry Chemical	Water**	AFFF
Index A/B	Under 126 ft.	Three (3)	150 lbs.	2,250 gallons	206 gallons

Note: (*) Reference FAR Part 139, Section 139.317, (i) Extinguishing agent substitutions.
Note: (**) Water used for protein foam production (AFFF).
Note: AFFF- Aqueous film forming foam.

Source: GCN ARFF Equipment/ Vehicle Requirements Summary, February 2003.

With regard to the longest aircraft, although not conducting an average of five departures per day, the GCN ARFF contingent is equipped and capable of responding to incidents involving Index B aircraft throughout the planning period. The Boeing 737-800 series aircraft, as identified in Table 4.13, represents an example of an Index B aircraft projected to utilize the airport on a consistent basis.

ARFF Response Times
Aside from facility and equipment requirements mandated by FAR Part 139, Paragraph 139.319 (I) identifies operational response times to be met by ARFF personnel. This requirement stipulates that within three minutes of an aircraft accident or incident, at least one required ARFF vehicle shall reach the midpoint of the farthest runway serving air carrier aircraft from its assigned location and begin application of fire extinguishing agents. The

location of the current ARFF station at GCN is situated approximately 1.008 miles from the center of Runway 3-21.

Interviews with GCN ARFF, as well as operations personnel, indicated that, utilizing the most direct route through the terminal area, the GCN ARFF response time from initial time of alarm to arrival on scene is approximately one minute and 50 seconds. Therefore, the current GCN ARFF response time is within the three minutes response time criteria established under FAR Part 139, Paragraph 139.319 (I). Once the construction of the new ARFF facility, located closer to the Runway 3-21 mid-point, is completed, this response time criteria must be revisited and recorded.

Snow Removal Equipment (SRE) Requirements

SRE facilities at GCN are designed to accommodate the storage of airport maintenance and snow removal equipment while at the same time providing a warm sheltered environment from moisture and various environmental contaminants.

The SRE and airfield maintenance facility needs analysis will focus primarily on the necessary equipment required to clear snow and ice from the airport during periods of heavy snow fall. This analysis will consist mainly of snow clearance requirements and specific equipment needs (i.e. rotary snow blowers, displacement plows, and material spreaders) for commercial service airports.

Existing SRE/Airport Maintenance Facilities

The existing SRE/airfield maintenance facilities are located southeast of the passenger terminal building being situated adjacent to the airport administration building. An inventory of the current SRE/maintenance facilities was described in Chapter II, Table 2.14. The current maintenance facility provides approximately 2,800 square feet of space to accommodate SRE vehicles and storage space for abrasives and dry chemicals to be stockpiled during the eight-month winter season in the Grand Canyon Region.

As with the new ARFF, facility plans are under way to begin construction of a new $3.5 million SRE/maintenance/ARFF building capable of accommodating four SRE/maintenance/snow removal vehicles, in addition to four ARFF vehicles. Guidance for facility layout, site selection, design and square footage requirements have already been determined. Therefore, this analysis will not concentrate on these areas, but rather to determine the necessary equipment needs of the required SRE equipment located at the airport to accommodate future demand activity. This analysis will first determine, based on climatic characteristics, the necessary SRE equipment to adequately clear all Priority I paved areas of snow at a commercial service airport. This analysis will then be accompanied by an assessment of the space requirements of the required SRE equipment as compared to current space available for SRE vehicles. Lastly, an assessment of the recommended snow clearance time requirements will be highlighted.

Clearance Priorities/Snow and Ice Control Requirements

GCN, being a small hub, commercial service airport, is required to have snow and ice control plan according to FAR Part 139 mandate, as well as the Airport Certification Manual. A snow and ice control plan must be current, complete and customized for local airport weather conditions. Given the fact that snow and icing conditions constitute an

emergency situation, it in crucial that airport operations personnel respond in a timely and efficient manner to ensure that Priority I paved areas are expeditiously returned to a "no worse than wet" pavement condition. Priority I paved areas are identified as the primary instrument runway, its principal taxiways and high speed turnoffs, designated commercial service apron areas, ARFF emergency access routes, and NAVAIDS for instrument runways. At GCN, snow removal operations will commence when snow depths reach ½-inch and/ or ice formation reaches ¼-inch of accumulation within Priority I paved areas. Table 4.25 contains information identifying the Priority I paved areas.

Table 4.25
Airport Snow Removal Equipment (SRE) Requirement Summary
Grand Canyon National Park Airport

GCN Priority I Paved Areas Summary

Airfield Component	Square Footage- Existing	Square Footage- Ultimate
Runway 3-21	1,350,000 sq. ft. (8,999' x 150')	1,500,000 sq. ft. (10,000 ' x 150')
Taxiway System	846,200 sq. ft.	913,800 sq. ft.
Taxiway Fillets	20,000 sq. ft.	22,000 sq. ft.
Air Carrier Apron	270,000 sq. ft.	270,000 sq. ft.
Miscellaneous	20,000 sq. ft.	20,000 sq. ft.
Total Priority I Square Footage	2,506,200 sq. ft.	2,725,800 sq. ft.

GCN Priority I Clearance Time Summary*

	Forecast Development Year				
Clearance Time Factors	Existing	2007	2012	2017	2022
Fixed Wing Commercial Service Operations**	5,500	10,900	11,200	12,100	13,600
Clearance Time (Hour)	1.5	1.0	1.0	1.0	1.0
Snow Tons/ Hour (for Clearance Operations)***	3,500	3,500	3,500	3,500	3,500

(*) FAA AC 150/5200-30A, Airport Winter Safety and Operations, Chapter 3, Section 17, paragraph a.
(**) Based on estimated annual snowfall amounts impacting fixed wing commercial service operations.
(***) FAA AC 150/5200-30A, Airport Winter Safety and Operations, Chapter II, Section 11, Figure 2-5.

GCN SRE Equipment Requirements Summary*

Equipment Piece	Current Inventory	Recommended Inventory	Advisable/ Potential Acquisition Needs
Rotary Snowplows	Two (2)	Three (3)	One (1)
Displacement Plows	Three (3)	Six (6)	Three (3)
Hopper Spreaders	Two (2)	Three (3)	One (1)
Power Sweepers	None	Four (4)	Four(4)

(*)FAA AC 150/5200-30A, Airport Winter Safety and Operations, Chapter 6, Section 38, paragraph a.

Source: ADOT, Aeronautics Division, February 2003.

Priority I Clearance Times

FAA AC 150/ 5200-30A, *Airport Winter Safety and Operations*, establishes ideal Priority I clearance times for commercial service airports. Before necessary snow/ ice clearance times can be determined, the annual airport operational activity must be established. Currently, GCN experiences approximately 43,600 annual fixed wing commercial service operations and is projected to accommodate 108,600 annual commercial service operations in the year 2022. The climatic analysis developed in the airport inventory indicated that the winter months in the Grand Canyon typically begin in October and last

until the following May. Average snow fall activity during this time period totals 46 inches with the heaviest snow fall amounts occurring during the month of January. It should be pointed out that this snow fall amount takes into account the entire Grand Canyon Region with the majority of snow activity occurring on the North Rim of the Canyon.

Given this operational and climatic information coupled with the relatively arid conditions of the South Rim, assumption were made as to the snow fall activity affecting annual commercial service activity based on months in which snowfall and ice could be expected. Of the eight winter months, January snow fall was estimated to impact approximately 12.5 percent of the annual commercial service fixed wing operational activity at the airport. This operational activity was then compared to the clearance times for commercial service airports with sufficient equipment to clear one inch of snow weighing up to 25 lbs./cubic foot from Priority I paved areas. Table 4.25 also identifies clearance times of Priority I paved areas throughout the planning period.

This data recommends that current GCN SRE capabilities be equipped to clear approximately 2.506 million square feet of the Priority I paved areas in 1.5 hours during periods of peak snowfall. Ultimate snow clearance times indicate that SRE capabilities at GCN are recommended to be equipped to clear approximately 2.725 million square feet of Priority I paved areas in one (1) hour during the year 2022.

SRE Equipment Needs
FAA AC 150/5220-20, *Airport Snow and Ice Control Equipment*, identifies minimum SRE equipment standards for commercial service airports, as well as providing guidance in the selection of snow blowers and displacement plows under varying winter operational conditions. This analysis will place emphasis on this AC in order to determine the SRE equipment required for GCN to accommodate existing and future aviation demand during winter operational conditions.

GCN SRE vehicles and associated equipment were discussed in Chapter II, Table 2.14. Currently, GCN is served by two rotary plows/snow blowers and three displacement plows, while both of the two rotary plows are equipped with a hopper spreader for abrasives and solid de-icing chemicals. The following analysis will confirm the adequacy of the current SRE equipment at the Airport and recommend any additional pieces required to meet forecast demand during winter and snow operations.

Rotary Snow Plows/Snow Blowers: Minimum equipment requirements for commercial service airports recommends one high speed rotary snowplow. For GCN, given the square footage of Priority I paved areas (2.506 million square feet- existing; 2.725 million square feet- ultimate), as well as the number of projected commercial service aircraft operations affected by winter conditions, three Class II medium sized, or two Class III intermediate sized rotary snowplows capable of removing approximately 3,500 tons of snow per hour are recommended for accommodating existing and ultimate demand at the airport. This analysis assumes a snow depth of one inch, plow efficiency of 70 percent and snow density at 25 pounds per cubic foot.

Displacement Plows: Each rotary snowplow is recommended to be supplemented by at least two displacement plows having equal capacity. Selection of a displacement plow blade is not an exact science and that different manufacturers would suggest alternative approaches tailored to prevailing weather conditions.

For purposes of this analysis, only recommendations regarding the number of displacement plows necessary to support the rotary plows at commercial service airports will be determined. At such time that aviation demand or weather conditions warrant the acquisition of additional displacement plows, applicable size, type of displacement plow and length of the displacement plow's blade will be determined. It is, therefore, recommended that, based on the existing local airport operational conditions, two small to medium sized displacement plows be utilized to support each of the rotary snowplows at the airport. Currently, GCN is equipped with three displacement plows, necessitating the probable need to acquire three additional displacement plows to accommodate existing and future winter conditions and aviation demand activity.

Power Sweepers/Hopper Spreaders: For commercial service airports, in addition to the above referenced snow removal pieces, for each 750,000 square feet of Priority I paved areas, one towed or self propelled air-blast power sweeper and one hopper spreader for abrasives and solid de-icing chemical is recommended. GCN is currently equipped with two hopper spreaders attached to each of the rotary snowplows. Additionally, it was determined that GCN is not equipped with towed or self propelled air-blast power sweepers. Therefore, it is recommended that with the addition of one rotary snowplow to the GCN SRE inventory, this piece of equipment should be outfitted with an additional hopper spreader to disperse abrasives and solid de-icing chemicals to the Priority I surfaces. Additionally, given the Priority I paved areas located at GCN, acquisition of four towed or self propelled power sweepers is advisable per minimum equipment requirements as recommended in FAA AC 150/ 5220-20.

Table 4.25, located on page 4-50, identifies the current inventory and recommended acquisition of SRE equipment (i.e. rotary snowplows, displacement plows, etc.) for existing and future utilization at the Grand Canyon National Park Airport.

It should be stated that although actual weather conditions and SRE equipment needs at the Airport may differ slightly from the SRE equipment needs analysis presented above, all recommended acquisitions are based on minimum FAA equipment needs for SRE procurement and use at commercial service airports.

Air Traffic Control Tower (ATCT) Facilities

The GCN ATCT facilities and personnel status are described in Chapter II, page 2-20. The GCN ATCT, commissioned in March 2003 and owned and operated by the FAA, is located mid-point of Runway 3-21 and has an above ground level elevation of 121 feet. From its location, as well as its top elevation, the GCN ATCT has unrestricted line-of-sight access to

all parts of the airport property including a clear and unobstructed view of the airspace in the immediate vicinity of the Airport.

Generally, ATC towers have a 20-year expected life-span dependent on local environmental, physical, and technological factors. The GCN ATCT, dependent on multiple factors regarding it overall physical condition and capability, may outlive its useful life on 2023. During latter portions of the long-term airport planning and development phase (2017-2022), an evaluation of facility condition, capacity, and technological capability is recommended to be conducted on the existing facility to determine the feasibility of planning for and/or development of a new ATCT facility. However, it is estimated that the GCN ATCT will remain in operation for at least 10 years beyond its 20 year design life span.

General Aviation Facility Requirements

General aviation is defined by the FAA as all aviation activity except that of air carriers certified in accordance with FAR Part 121, 123, 127, 125 and 135 excluding military aircraft and operational activity. General aviation special requirements at GCN were calculated for the following terminal area components required for general aviation passengers and airport patrons:

- Airport Terminal Facilities (FBO passenger spatial needs)
- Aircraft Parking Apron Needs
- Public Auto Parking

The process of calculating the necessary general aviation facilities at GCN relied on information derived from Chapter 3, as well as information generated within the Airport Peaking Characteristics, *General Aviation Operational Peaking Characteristics*, section of this chapter. Additionally, the general aviation facilities at GCN were discussed and referenced within Chapter II, Terminal Area/Landside Facility Inventory section of the inventory chapter.

General Aviation Terminal Building Facilities

Grand Canyon Airlines (GCA), located adjacent to the ARFF facility, serves as the sole FBO provider at the airport. Additionally, GCA's 5,473 square foot air tour facility serves as the general aviation FBO that includes accommodations for public telephone and restrooms, as well as a pilot/flight planning and passenger lounge. For calculating purposes, it is assumed that approximately 20 percent of the square footage of the facility (approximately 1,100 square feet) is reserved for general aviation pilot/ passenger/customer waiting and circulation area.

General aviation operational peaking characteristics were described in Table 4.2 of the *General Aviation Operational Peaking Characteristics* section of this chapter. As stated within the *General Aviation Passenger Peaking Characteristics* section of this chapter, it is assumed that 100 percent of the passenger activity taking place at the Airport was a result of commercial air tour operational activity. This factor is important in that peak hour

passenger activity generally will aid in determining the necessary terminal building space requirements for general aviation users at airports. In this case, absent general aviation passenger activity, assumptions were made as to the number of pilots/passengers per peak hour operations that could conceivably arrive at the Airport during peak periods of general aviation activity. Therefore, it is estimated that, throughout the 20-year planning period, 1.5 pilots/passengers that arrive at GCN will utilize GCA's general aviation facilities.

To determine the amount of space required to accommodate general aviation peak hour pilots/ passengers at GCA's facilities, a total of 45 square feet per peak hour passenger was allotted. This figure represents 30 percent of the space required for commercial service passengers due to the fact that less ticketing, corridor, queing and circulation, as well as lobby and waiting area space is needed for general aviation pilots/ passengers. Table 4.26 reveals the current and future general aviation terminal building space requirements for the Grand Canyon National Park Airport.

Table 4.26
General Aviation Terminal Building Area Requirements
Grand Canyon National Park Airport

General Aviation Operational Activity/ Factors	Existing	2007	2012	2017	2022
Peak Hour Operations (Local + Itinerant)	3	4	5	5	7
Peak Hour Passengers/ Peak Hour Operations	1.5 peak hour passengers per operation				
General Aviation Peak hour Passengers	5	6	8	8	11
Square Feet/ Peak Hour Passenger	45 square feet				
General Aviation Terminal Area Requirement (sq. ft.)	225	270	360	360	495
GCA General Aviation Terminal Area (sq. ft.)	1,100	1,100	1,100	1,100	1,100
GCA Terminal Area Surplus/ (Deficit) (sq. ft.)	875	830	740	740	605

Source: General Aviation Terminal Area Requirements Summary, January 2004.

The general aviation terminal area facilities at Grand Canyon Airlines, based on the terminal building spatial requirements analysis, are adequate to accommodate the current and projected general aviation peak hour demand at GCN throughout the planning period.

General Aviation Aircraft Parking Apron Facilities

The general aviation contingent of based aircraft and operational activity at GCN are largely contributed by single and multi-engine piston-powered aircraft. Occasionally, a large turbine powered (turbo-prop/jet) transient aircraft will conduct operational activity at the Airport and occupy apron area while taking on fuel. At present, there are three privately owned single engine general aviation aircraft based at the airport. These aircraft are assumed to be stored on the general aviation apron thereby increasing the peak hourly apron demand for general aviation aircraft. Table 4.27 indicates the necessary apron area requirements to accommodate general aviation aircraft during existing and ultimate peak hour periods of activity at GCN.

The general aviation apron area requirements were determined by referencing the Peak Month/ Average Day (PMAD) activity projections discussed at the beginning of this chapter. Peak hour general aviation operations conducted by each category of general

aviation aircraft (i.e. single engine, multi-engine and turbine/ jet) anticipated to utilize the Airport was assigned a square yardage figure necessary to adequately accommodate the aircraft on the apron. The total square yardage required by each aircraft category coupled with additional maneuvering area determined the amount of space necessary to accommodate the general aviation aircraft on the general aviation apron during peak hour activity.

Table 4.27
General Aviation Aircraft Parking Apron Requirements
Grand Canyon National Park Airport

General Aviation Operational Activity/ Factors		Existing	2007	2012	2017	2022
Peak Hour Operations (Local + Itinerant)		3	4	5	5	7
Peak Hour Apron Demand	Single Engine*	(3) 1	(3) 2	(3) 3	(3) 3	(3) 5
	Multi-Engine	1	1	1	1	1
	Turbine/ Jet	1	1	1	1	1
Parking Area Per Aircraft (sq. yd.)	Single Engine*	560	700	840	840	1,120
	Multi-Engine	280	280	280	280	280
	Turbine/ Jet	330	330	330	330	330
Parking Area + Maneuvering Area per Aircraft (20% of sq. yd.)	Single Engine*	670	840	1,010	1,010	1,340
	Multi-Engine	340	340	340	340	340
	Turbine/ Jet	400	400	400	400	400
General Aviation Apron Area Requirement (sq. yd.)		1,410	1,580	1,750	1,750	2,080
General Aviation Apron Area (sq. yd.)		14,600	14,600	14,600	14,600	14,600
General Aviation Apron Area Surplus/ (Deficit) (sq. yd.)		13,190	13,020	12,850	12,850	12,520

(*) Indicates that three (3) based aircraft occupy general aviation apron area in addition to the demand for peak hour apron requirements. Therefore, peak hour apron demand takes into account the demand by these three (3) aircraft.

Source: General Aviation Terminal Area Requirements Summary, January 2004.

The general aviation apron area requirements indicated that there is a demand for approximately 1,410 square yards of space at GCN during peak hour periods of activity. Ultimately, it is indicated that there is a potential demand for approximately 2,100 square yards general aviation apron space during peak hour activity leaving a total of approximately 12,500 square yards of surplus apron area to be utilized for additional small and large general aviation itinerant aircraft throughout the planning period. Based on the general aviation apron area needs analysis, there will continue to be surplus apron area to accommodate additional peak hour general aviation aircraft and, therefore, adequate to accommodate existing and future peak hour demand levels.

General Aviation Public Auto Parking Facilities

The methodology utilized to determine future general aviation (GA) public auto parking space requirements is primarily based on the same recommendations and methodology utilized for determining the commercial service public parking requirements at GCN. For GCN, a ratio of 1.5 parking spaces per peak hour passenger, based on the Peak Month/Average Day (PMAD) general aviation peaking forecasts, was determined to provide the most likely scenario for parking space requirements during peak periods of general aviation operational activity. A square footage requirement of 330 square feet per passenger vehicle, which includes maneuvering area, will be utilized to determine the overall area necessary to accommodate future parking demands. Table 4.28 summarizes

the existing and ultimate general aviation parking area requirements for the Grand Canyon Nation Park Airport.

Table 4.28
General Aviation Public Parking Area Requirements
Grand Canyon National Park Airport

Year	Peak Hour GA Passenger Demand	Parking Spaces/ Peak Hour GA Passenger	Square Footage Demand/ Parking Space (sq. ft.)	Total General Aviation Parking Demand	
				Spaces	Sq. Ft.
Existing	5			8	2,640
2007	6			9	2,970
2012	8	1.5	330 sq. ft.	12	3,960
2017	8			12	3,960
2022	11			17	5,610

Source: General Aviation Parking Requirements Summary, January 2004.

General aviation demand at GCN that require parking space currently park in the main airport terminal building parking lot that has found to be inadequate for existing demand during peak periods of airport activity. Upon construction of a new airport passenger terminal building and associated parking facilities, it is recommended that parking area measuring approximately 5,600 square feet accommodating nearly 17 parking spaces be developed specifically for use by Grand Canyon Airlines and GCN general aviation airport users.

Additional Landside Facility Requirements

Concepts unique to GCN including on-airport housing and residential use, as well as potential intermodal transportation (aviation, railway and roadway) infrastructure needs necessary to serve the local area are further discussed and examined as part of Chapter 5, *Alternatives Analysis.* The additional landside facility needs evaluated within Chapter 5 are not intended to be associated with any particular Grand Canyon National Park stakeholder including the NPS, NFS, FAA, ADOT or GCRR but are intended to highlight potential needs to meet the various demands of residents and tourists in the Grand Canyon, Tusayan, Coconino County and northern Arizona region.

Summary of Airport Facility Requirements

Given the complexity and breadth of the facility requirements developed for the Grand Canyon National Park Airport, a summary of the major airfield, terminal area and support facility needs will be discussed and highlighted in text format rather than table format.

Airfield Facility Requirements
Major airfield facility requirements recommended throughout the 20-year planning period include a potential extension of Runway 3-21 1,001 feet to the southwest of the existing Runway 3 threshold. Additional airfield requirements associated with this runway extension is the potential extension of Taxiway P 1,001 feet to the southwest providing access/egress to the Runway 3 threshold. Additional taxiway facility recommendations include the reconfiguration of Taxiway E to serve as a high-speed exit taxiway for aircraft arriving on

Runway 3. Lastly, a mitigative course of action is recommended to address the location of the Papillion Grand Canyon Helicopter facility within the Runway 21 Runway Protection Zone (RPZ).

Terminal Area Requirements
The major terminal area facility recommendation for the forecast 20 year planning period is the development and construction of a 60,000 square foot passenger terminal building to replace the existing terminal facility. The ultimate terminal building will accommodate six (6) to eight (8) Type A aircraft gate spaces, serve approximately 279 peak hour enplaned passengers and be equipped with approximately 670 linear feet of terminal curbside frontage. Parking facilities associated with the newly developed passenger terminal building include 419 short-term and long-term public parking spaces, 63 employee parking spaces, rental car parking area and approximately 50,000 square feet of passenger bus and shuttle van parking area.

Airport Support Facility Requirements
Snow Removal and Equipment (SRE) needs was analyzed and determined to require the acquisition of one additional rotary snowplow, three displacement plows, one hopper/spreader for abrasives and solid de-icing chemicals, as well as four power sweepers for debris and snow clearing.

The next chapter of the Master Plan Update, titled *Airport Alternatives Analysis*, will include alternative development concepts to accommodate the range of projected requirements needed to satisfy forecast operational and passenger enplanement demands.

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