AIRPORT MASTER PLAN

CHAPTER 3 - DEMAND/CAPCITY ANALYSIS & FACILITY REQUIREMENTS

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PLANNING AND DESIGN

INTRODUCTION

This chapter identifies the specific types and quantities of infrastructure and facilities needed at San Angelo Regional Airport to meet the Federal Aviation Administration's (FAA) approved forecasted aviation demand presented in Chapter 2. The results of the capacity and demand analysis, aviation demand forecasts, and other planning methodologies, determine the requirements for the airfield, landside, and support areas of the Airport.

In addition to objective analyses, considerations were given to recommendations and feedback from airport personnel, tenants, airport businesses, and other stakeholders. The 20-year planning period for the Airport Master Plan begins with the base year of 2017 and extends through 2037. Development needs are broken down into short-term (1-5 years), mid-term (6-10 years), and long-term (11-to-20 years) planning periods. Short-term planning is focused on addressing immediate deficiencies, mid-term planning focuses on a more detailed assessment of needs, and long-term planning primarily focuses on the ultimate role and needs of the Airport. It is important to keep in mind that actual activity at SJT may vary over the 20-year planning period and may be higher or lower than what the aviation demand forecast predicted. By using the three planning periods (short-, mid-, and long-term), the City of San Angelo can make informed decisions regarding the timing of development, which will result in fiscally responsible and demand based development of SJT. For review, a summary of the FAA approved aviation demand forecast for each planning period for San Angelo Regional Airport is provided in the **Table 3A** below.

TABLE 3A
San Angelo Regional Airport Forecast Summary

	2017	2022	2032	2037
Based Aircraft	176	182	189	202
Annual Operations	78,065	81,209	82,901	86,791
Passenger Enplanements	60,095	63,758	67,643	76,136

Source: *Landrum and Brown Analysis*

DEMAND / CAPACITY ANALYSIS

Introduction and Background

This analysis assesses the airfield capacity under its future runway and taxiway configuration (taking into account the future decommissioning of Runway 9-27) and compares it to the Airport's existing and future aircraft operations totals. The goal and result provide an update regarding the Airport's ability to accommodate future levels of aircraft operations.

Airfield Capacity

Airfield capacity is a measure of terminal area airspace and airfield saturation. It is defined as the maximum rate at which aircraft can arrive and depart an airfield with an acceptable level of delay. Measures of capacity include the following:

- **Annual Service Volume**: The annual capacity, or the maximum level of annual aircraft operations, that can be accommodated on the runway system with an acceptable level of delay. An airport's Annual Service Volume (ASV) has been defined by the Federal Aviation Administration's (FAA) as, "a reasonable estimate of an airport's annual capacity. It accounts for differences in runway use, aircraft mix, weather conditions, etc., that would be encountered over a year's time." Therefore, ASV is a function of the hourly capacity of the airfield and the annual, daily, and hourly demands placed upon it. ASV can be derived from predetermined tables within the FAA Advisory Circular (AC) 150/5060-5, *Airport Capacity and Delay* that is primarily based on the configuration of the airfield's runway system. Alternatively, ASV is estimated by multiplying the existing daily and hourly operation ratios by a weighted hourly capacity. The latter approach is based on the availability of reliable, detailed aircraft operational data.

- **Hourly Capacity**: The maximum number of aircraft operations that can take place on the runway system in one hour taking into account the variables mentioned under the ASV estimate. Because of these variables and peaking considerations, it is not a simple division of time with the stated ASV, and theoretical estimates can be higher than practical capacity when delay is not factored.

A variety of techniques have been developed for the analysis of airfield capacity. The current technique accepted by the FAA is described in the FAA Advisory Circular (AC) 150/5060-5, *Airport Capacity and Delay*. The Airport Capacity and Delay Model (ACDM) uses the following inputs to derive an estimated airport capacity:

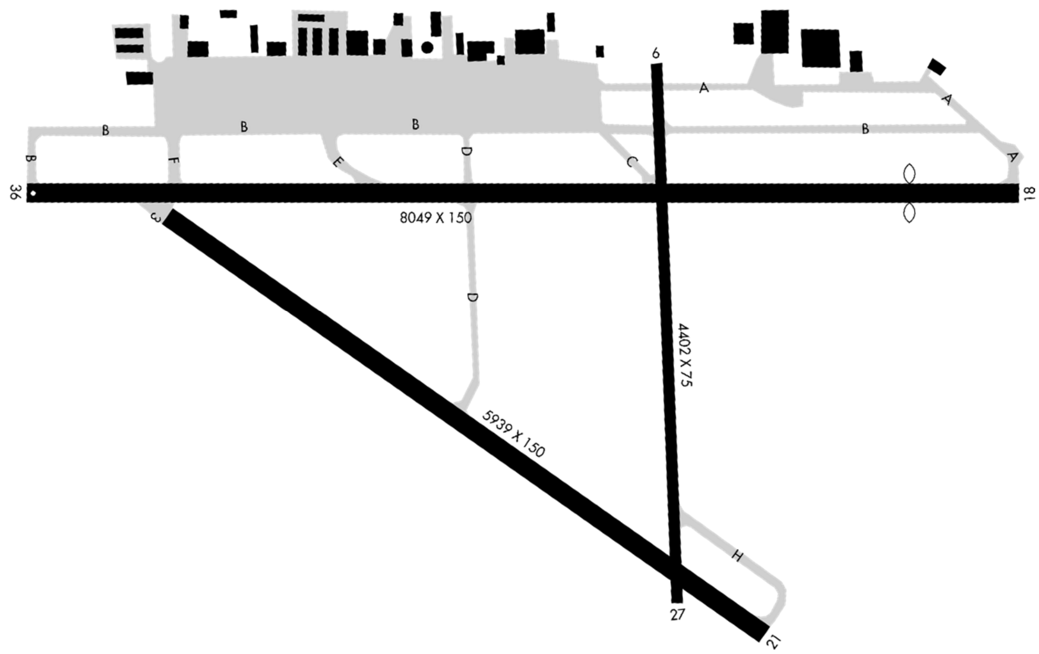
- Airfield layout and runway use
- Meteorological conditions
- Navigational aids
- Aircraft operational fleet mix
- Touch and go operations

Each input used in a calculation of airfield capacity is described in the following sections.

Airfield Layout and Runway Use

The existing airfield layout consists of three runways described below and shown in **Exhibit 3A** below. The Airport has one primary runway (Runway 18/36), one crosswind runway (Runway 3/21), and one additional runway (Runway 9/27). Runway 18/36 is the only runway with a full parallel taxiway. As a part of a previous study, Runway 9-27 has been identified as unnecessary to accommodate operations and will be decommissioned once it reaches the end of its useful life. For this reason, Runway 9-27 has been excluded from this capacity analysis.

EXHIBIT 3A
Existing Airfield Layout



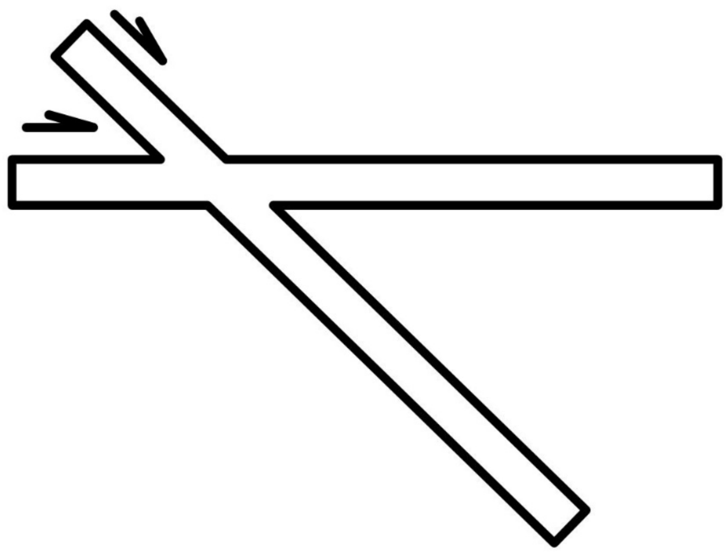
Note: At the time this exhibit was created, the current FAA Chart Supplement had not yet been updated to show the Taxiway C and E realignments. Both taxiways have since been demolished and replaced with new, 90-degree connector taxiways. Taxiway Charlie was reconstructed to the north of Runway 9-27 and Taxiway Echo was reconstructed midway between Taxiways Delta and Foxtrot.

Source: FAA Chart Supplement, effective 28 MAR 2019 to 25 APR 2019

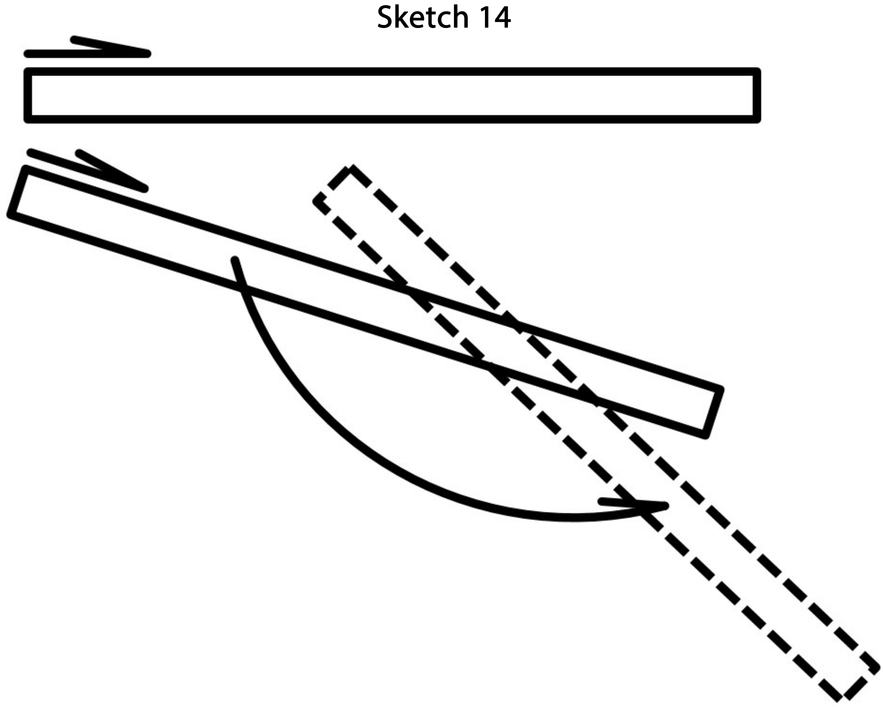
The runway configuration at SJT shares similarities with both Sketch 9 and Sketch 14 of Figure 2-1 in AC 150/5060-5 (See **Exhibit 3B** below). The runways are neither completely intersecting as shown in Sketch 9, nor completely detached as shown in Sketch 14. As discussed later in this section in more detail, Sketch 9 was used as it was determined to provide a more accurate and conservative estimate of capacity.

EXHIBIT 3B
Sketches from Figure 2-1, *AC 150/5060-5*

Sketch 9



Sketch 14



The capacity sketches 9 and 14 in the Advisory Circular 150/5060-5, correspond to the operational capability of airfields in those configurations and will be utilized to estimate existing capacity.

East flow of air traffic is the predominant flow of aircraft at SJT. According to an analysis of the wind conditions at the airport, Runway 18 and Runway 3 are utilized most frequently. Runway 9-27 is primarily used for operations by general aviation aircraft.

Meteorological Conditions

Aircraft navigate under either Visual Flight Rules (VFR) or Instrument Flight Rules (IFR). The term VFR refers to rules that govern the procedures for conducting flight under visual meteorological conditions (VMC) where visibility is sufficient for pilots to see and avoid other traffic.

The term IFR refers to a set of rules governing the conduct of flight under instrument meteorological conditions (IMC) where pilots rely on instrumentation to navigate. The capacity of an airfield can be negatively impacted based on poor weather conditions. Under Federal Aviation Regulations (FAR) Part 91, *General Operating Flight Rules*, VFR and IFR are defined as:

- **Visual Flight Rules (VFR)** – having flight visibility of at least three statute miles and a cloud ceiling of at least 1,000 feet. This can also be referred to as VMC, or Visual Meteorological Conditions.

- **Instrument Flight Rules (IFR)** – having flight visibility less than three statute miles and a cloud ceiling of less than 1,000 feet. This can also be referred to as IMC, or Instrument Meteorological Conditions.

A review of the wind data at SJT revealed that over the past 10 years, only eight percent of all of the wind readings have occurred in IFR conditions.

Navigational Aids

As of May 2019, the Airport has ten published Instrument Approach Procedures (IAP). Three of these approaches are designed for military operations and are not authorized for civilian use. As a result of the Airport having predominately VFR weather conditions and the focus of this study on the maximum capacity of the facility under those conditions, these procedures only play a role in estimating the hourly capacity under IFR conditions, and the weighted capacity that will be calculated later in this effort.

Based Aircraft Operational Fleet Mix

The existing based aircraft fleet mix was analyzed as a part of the forecast chapter and is as follows:

TABLE 3B
Based Aircraft Fleet Mix

Aircraft Type	Total Aircraft	%
Single-engine Piston	103	59%
Multi-engine Piston	16	9%
Turboprop/Jet	50	28%
Helicopter	7	4%

Note: *Aircraft within the "Military" category as listed on the 5010 have been incorporated into SJT's existing fleet mix. See Table 2V in Forecast chapter for additional notes.*

Source: *FAA Form 5010-1, Airport Master Record, December 31, 2017; C&S Engineers, Inc. analysis 2019*

Fleet mix index is a key component of calculating annual service volume and is expressed mathematically as %(C+3D) with "C" representing the percentage of Class C aircraft, and "3D" representing 3 times the percentage of Class D aircraft. The FAA defines Class C as aircraft having a maximum certified takeoff weight of 12,500 lbs. – 300,000 lbs., and Class D as aircraft over 300,000 lbs. Class C aircraft account for approximately 43% of the total fleet mix at SJT, with no operations by Class D. This fleet mix is consistent with FAA guidance and the historical based aircraft mix. The fleet mix index of 21-50 will be used for this analysis.

Touch-and-Go Operations

Touch-and-go operations are generally defined as an aircraft that lands and departs on a runway without stopping or exiting the runway. FAA Advisory Circular 150/5060-5, Airport Capacity and Delay, states:

> "Touch and go operations are normally associated with flight training. The number of these operations usually decrease as the number of air carrier operations increase, as demand for service approaches runway capacity, or as weather conditions deteriorate."

At SJT, touch-and-go training accounts for approximately 17% of all operations. Touch-and-go operations are factored into the FAA's assumptions in determining the ASV and hourly capacities from Figure 2-1 in the Advisory Circular.

Demand Capacity Estimate

This section develops an updated demand capacity estimate for San Angelo Regional Airport based on available current information and resources that include the FAA Advisory Circular, as well as The Airport Cooperative Research Program's (ACRP), Report 79, *Evaluating Airfield Capacity*.

ACRP's Report 79, *Evaluating Airfield Capacity* provides a spreadsheet tool to assist in calculating the ASV based on a weighted hourly capacity utilizing actual demand ratios from the Airport. Using only the table provided in the AC for estimating ASV is sufficient for high-level capacity analyses and requires only minimal data to query results, but does not allow the user to manipulate assumptions with airport-specific inputs (e.g., VMC/IMC Occurrence, Peaking Characteristics, etc.). Using the spreadsheet tool allows for a tailored analysis, taking into consideration airport specific variables and providing a more accurate ASV estimate.

To calculate ASV, a weighted average of the hourly capacity over the year is calculated using a formula provided in FAA's guidance and checked utilizing ACRP's spreadsheet tool. The following provides the formula and explains each component.

ASV Formula:
$ASV = C_w * D * H$

C_w = the weighted average hourly capacity of the airfield;

D = the ratio of annual to ADPM demand; and

H = the ratio of ADPM demand to peak-hour demand.

ADPM = Average Day Peak Month operations

The FAA and ACRP guidance recommend that ratios for D and H should be calculated using data from airport records, but when data is not available, some default assumptions can be used. For this effort, these assumptions are noted accordingly.

ACRP's Report 79, *Evaluating Airfield Capacity* provides the following descriptions and information regarding the inputs:

> "*The D factor measures seasonal variation in monthly demand, where a value of 365 would indicate that all months have the same demand. Very low D values (e.g., values less than 300) would indicate substantial seasonality typical of vacation destinations.*
>
> *"The H factor measures variation over the hours of the day, where a value of 24 would indicate that all hours of the day have the same demand. Much lower H values (e.g., values less than 12) would indicate substantial peaking in demand over the hours of the day."*

Key assumptions utilized in this estimate include:

- Runway configuration that assumes two intersecting runways similar to Sketch 9 of Figure 2-1 in FAA AC 150/5060-5. The ACRP *Airfield Capacity Estimation using Spreadsheet Models* was utilized to provide a more accurate estimate of existing capacity. This resulted in a lower and more conservative estimate than using simply Figure 2-1 of the AC 150/5060-5.

- Air carrier and general aviation aircraft fleet mix with a 21-50 (C+3D)% ratio.

The results yield the following ASV and Hourly Capacities as reported by the ACRP spreadsheet tool.

TABLE 3C
ASV and Hourly Capacity Estimate

Annual Service Volume	
141,300 Operations (Takeoffs and Landings)	
Hourly Capacity	
VFR = 86	IFR = 62

Source: ACRP Airfield Capacity Estimation using Spreadsheet Model

The estimated capacity was also calculated using Sketch 14 from Figure 2-1 of FAA AC 150/5060-5. This input gave a much higher estimate at 225,000 operations a year and a maximum number of hourly operations at 108 VFR or 57 IFR. It was determined that the use of the ACRP spreadsheet model and Sketch 9 provided a more accurate result. This is primarily due to Runways 18-36 and 3-21 not completely intersecting at SJT but are close enough to severely restrict simultaneous operation. Additionally, it is anticipated that during the alternatives analysis, options to lengthen Runway 3-21 so that it completely intersects with Runway 18-36 will be assessed. Using the more restrictive and conservative capacity estimate of 141,300 annual operation allows the Airport to predict potential delays and to start planning for capacity improvements earlier.

Forecast Aircraft Operations Demand versus Capacity

This section compares the updated ASV to the most recent existing operational data as well as to the forecast number of annual operations. The comparison of these two metrics results in the Annual Capacity Ratio.

TABLE 3D
Annual Operations versus ASV

Year	Annual Operations	Annual Service Volume	Annual Capacity Ratio
2017	78,065	141,300	55%
2022	81,209	141,300	57%
2027	82,901	141,300	59%
2037	86,791	141,300	61%

Source: C&S Engineers, Inc. analysis 2019

The table above indicates that San Angelo Regional Airport has theoretical capacity to accommodate additional aircraft operations, both in existing conditions and in the forecast 2037 conditions. However, it should be noted that within the existing operational activity, peak demand can still create operational delays.

FAA AC 150/5060-5 states: "*As demand approaches capacity, individual aircraft delay is increased. Successive hourly demands exceeding the hourly capacity result in unacceptable delays.*

When the hourly demand is less than the hourly capacity, aircraft delays will still occur if the demand within a portion of the time interval exceeds the capacity during that interval. Because the magnitude *and scheduling of user demand is relatively unconstrained, reductions in aircraft delay can best be achieved through airport improvements which increase capacity."*

While the Airport is currently experiencing no delays, a new entrant airline that schedules flights during the current peak hour has the potential to generate delays even without exceeding the ASV. Currently the level of commercial traffic volume does not conflict with the general aviation operations. Additionally, the vast majority of the unmanned systems operations at the Airport take place overnight and thus have no adverse impact on either the commercial or general aviation activity.

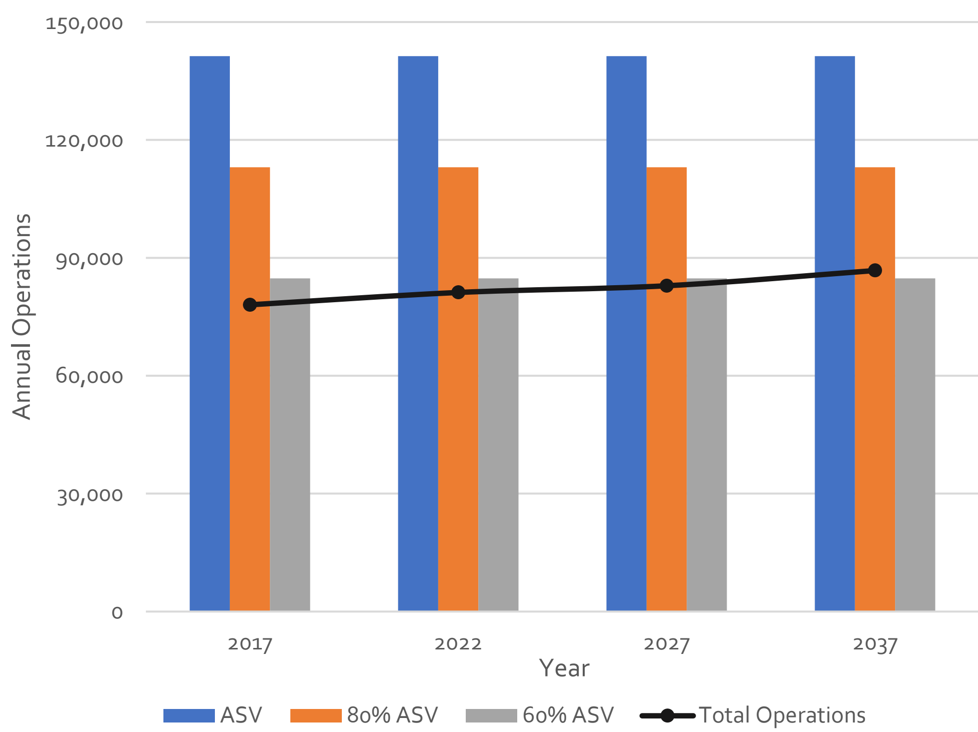
Demand Capacity Summary

According to the FAA, the following guidelines should be used to determine necessary steps as demand reaches designated levels

- 60 Percent of ASV: The threshold at which planning for capacity improvements should begin.
- 80 Percent of ASV: The threshold at which planning for improvements should be complete and construction should begin.
- 100 Percent of ASV: The airport has reached the total number of annual operations it can accommodate, and capacity-enhancing improvements should be made to avoid extensive delays.

The current number of annual operations for the base year of 2017 is 78,065. This is approximately 55 percent of the estimated ASV. **Exhibit 3C** depicts the relationship of the aviation demand forecast for SJT and the current ASV. Based on the ratio between the Airport's existing ASV and forecasted growth in operations, there is not currently a need for the Airport to plan for capacity enhancing runway and taxiway projects within the forecast period.

EXHIBIT 3C
Annual Service Volume vs. Annual Demand



Source: *C&S Engineers, Inc. analysis 2019*

AIRPORT DESIGN STANDARDS

FAA Advisory Circular 150/5300-13A, *Airport Design*, identifies the design standards to be maintained at the Airport. These design criteria provide a guide for airport designers to assure a reasonable amount of uniformity in airport facilities. Any criteria involving widths, gradients, separations of runways, taxiways, and other features of the landing area must necessarily incorporate wide variations in aircraft performance, pilot technique, and weather conditions.

Critical Aircraft

As discussed in the previous chapter, the critical aircraft is the most demanding aircraft type that makes regular use of the airport. The critical aircraft at SJT was selected as part of the analysis of the existing and future operations completed during the forecast process. The critical aircraft for the larger two runways was determined to be a CRJ-700 for existing conditions and a CRJ-900 for the future conditions. Due to the reduced length and width of Runway 9/27, it is not suited to accommodate operations by the larger aircraft. It has been assigned the Cessna Citation Sovereign as a separate critical aircraft that more closely represents the size of aircraft using this runway.

TABLE 3E
Critical Aircraft Characteristics

Period	Aircraft	MTOW	AAC	Approach Speed	ADG	Wingspan	TDG
			Runway 18-36 and Runway 3-21				
Existing	CRJ-700	75,000	C	135 Knots	III	76.3 FT	2
Future	CRJ-900	85,000	C	140 Knots	III	81.5 FT	2
			Runway 9-27				
Existing	Cessna Citation Sovereign	30,775	B	108 Knots	II	63.33	1B
Future	Cessna Citation Sovereign	30,775	B	108 Knots	II	63.33	1B

Source: *FAA Aircraft Characteristics Database V2*

Airport Reference Code (ARC)

Per FAA AC 150/5300-13A, the ARC combines the AAC and ADG of the critical aircraft and signifies the airports highest runway design code, minus the visibility component of the RDC. Airport improvements should be planned and developed per the established ARC for the entire airport. *"The ARC should be used for planning and design only and does not limit the aircraft that may be able to safely operate on the airport".* In other words, the ARC is derived from the critical aircraft, but the airport may be able to accommodate larger aircraft. For Runways 18/36 and 3/21 the existing and future ARC is C-III. For Runway 9/27 the existing and future ARC is B-II.

Runway Design Code (RDC)

The Runway Design Code (RDC) is used to identify the standards to which a given runway is to be built and maintained. Airports with multiple runways often have different RDCs. The applicable RDC is based on the AAC and the ADG of the critical aircraft and the approach visibility minimums of each runway end. For the purposes of the RDC, the approach visibility minimums are listed as Runway Visual Range (RVR). **Table 3F** below shows the different RVRs and the corresponding visibility minimums in statute miles.

TABLE 3F
Visibility Minimums

Runway Visual Range (RVR) ft[1]	Instrument Flight Visibility Category (Statute Mile)
5000	Not lower than 1 mile
4000	Lower than 1 mile but not lower than ¾ mile
2400	Lower than ¾ mile but not lower than ½ mile
1600	Lower than ½ mile but not lower than ¼ mile
1200	Lower than ¼ mile

Note: *[1] RVR values are not exact equivalents*

Source: *AC 150/5300-13, Airport Design*

The RDC for each runway end at SJT is listed in the table below. As seen in **Table 3G** below, the RDC may differ on each runway end due to the visibility minimums of the instrument approaches into each runway.

TABLE 3G
Runway Design Codes at SJT

Runway End	Runway Design Code (RDC)
Runway 18	C-III-5000
Runway 36	C-III-VIS
Runway 3	C-III-2400
Runway 21	C-III-4000
Runway 9	B-II-VIS
Runway 27	B-II-VIS

Source: *aeronav.faa.gov*

Taxiway Design Group (TDG)

In addition to runway design standards, the FAA sets design standards for airport taxiway systems based on the established critical aircraft's ADG and Taxiway Design Group (TDG). Both the existing critical aircraft (CRJ-700) and future critical aircraft (CRJ-900) fall within TDG 2 based on their Main Gear Width (MGW) and Cockpit to Main Gear (CMG) distance. The table below presents specific taxiway design standards based on the Airport's ADG and TDG.

TABLE 3H
Taxiway Design Group (TDG) II Dimensional Standards

Item	Dimensions (ft.)
Taxiway Width	35
Taxiway Edge Safety Margin	7.5
Taxiway Shoulder Width	15

Source: *AC 150/5300-13A, Airport Design*

AIRSIDE REQUIREMENTS

Runway Requirements

Runway Width

Runway width standards are established in FAA AC 150/5300-13A and are based on RDC criteria. The table below outlines the FAA runway width standards and the existing runway facilities at SJT. As can be seen in the table below, the existing runway widths satisfy the FAA requirements.

TABLE 3I
Runway Width Requirements

Runway	RDC	FAA Standard	Existing Width
Runway 18-36	C-III-5000 / C-III-VIS	150 FT	150 FT
Runway 3-21	C-III-2400 / C-III-4000	150 FT	150 FT
Runway 9-27	B-II-VIS	75 FT	75 FT

Source: *aeronav.faa.gov*

Runway Length: Takeoff and Landing Distance

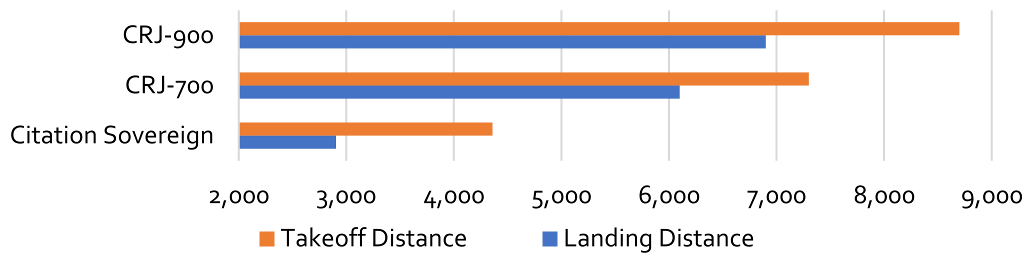
Runway length requirements are based on a variety of factors, the most notable of which is the takeoff distance of the critical aircraft operating on the runway. The takeoff length requirements are often the most critical for measuring runway length required since departing aircraft have a full fuel load thus increasing the amount of runway required. Temperature and airport elevation are some of the other factors that affect runway length requirements. The relatively high average temperature at SJT as well as a field elevation of nearly 2,000 feet above mean sea level increases the runway length required. FAA AC 150/5325-4B, *Runway Length Requirements of Airport Design*, provides guidance on determine the runway length required.

For runways with a critical aircraft with a Maximum Takeoff Weight (MTOW) of more than 60,000 pounds, the AC 150/5325-4B states that the landing distance of the critical aircraft, at maximum weight, and corrected for airport elevation and temperature, will be used to determine the required runway length for takeoff. This methodology was applied to both Runway 18-36 and Runway 3-21. It was found that the existing (CRJ-700) and future critical aircraft (CRJ-900) would require 7,300 feet and 8,700 feet for takeoff. Runway 18 is currently the only runway direction that can accommodate the takeoff distance of the existing critical aircraft, the CRJ-700. Due to the declared distances in effect, discussed in a later section, the amount of runway available for takeoff in the Runway 36 direction is limited to 7,160 feet.

In order to provide the CRJ-900 with the required takeoff distance, Runway 18-36 would require an extension of approximately 650 feet to bring it to a total length of 8,700 feet. However, it should be understood that calculating runway length requirements using MTOW assumes that the aircraft is configured to travel its maximum range. Nearly all of the commercial flights originating out of SJT are direct flights to Dallas Fort Worth International Airport. This destination is approximately 200 nautical miles and would not require operating the aircraft at MTOW. Given that the majority of flights do not require MTOW, the length of the runways is sufficient for existing operations. In the future if the stage length of outbound flights increases, the length of the runway may become a limiting factor at which time an extension should be considered. That said, alternatives to increase the landing and takeoff distance available for Runway 36 will be considered as part of the alternatives evaluation.

The runway length requirements for Runway 9-27 were assessed by looking at the performance of the Cessna Citation Sovereign. It was found that Runway 9-27 had sufficient length for the critical aircraft. The calculated takeoff distances are shown in the exhibit below.

EXHIBIT 3D
Existing Airfield Layout



Note: *Takeoff and landing distances are adjusted to account for non-standard temperature and altitude.*
Source: *1) CRJ700 Aircraft Airport Planning Manual, CSP B-020, Revision 15, dated Dec 17/2015.*
2) CRJ900 Aircraft Airport Planning Manual, CSP C-020, Revision 11, dated Dec 17/2015.
3) Citation Sovereign Flight Planning Guide, April 2011

Runway Designation

As specified in FAA AC 150/5340-1L, "the designator number is the whole number nearest the one-tenth of the magnetic azimuth along the runway centerline when viewed from the direction of the approach." To calculate the magnetic azimuth, you must first determine the runways true bearing and then apply the magnetic declination. Magnetic declination is defined as the difference between true north and magnetic north. The value of magnetic declination varies over time and location. It is a natural process and cause the need to periodically the re-designate runways. The table below shows the runway's true and magnetic bearing, along with the current magnetic declination.

As can been seen in the **Table 3J** below, Runway 18-36 and Runway 9-27 are currently correctly designated and do not require a change. However, the magnetic declination has changed enough that Runway 3-21 should now be designated as Runway 4-22.

TABLE 3J
Runway Designation Calculation

Runway End	True Bearing	Magnetic Declination	Magnetic Bearing	Runway Designation
Runway 18	187.40°	5° 14′ E ± 0° 20′	182.17°	18
Runway 36	7.40°	5° 14′ E ± 0° 20′	2.17°	36
Runway 3	43.23°	5° 14′ E ± 0° 20′	38.0°	4
Runway 21	223.23°	5° 14′ E ± 0° 20′	218.0°	22
Runway 9	97.57°	5° 14′ E ± 0° 20′	92.34°	9
Runway 27	277.57°	5° 14′ E ± 0° 20′	272.34°	27

Source: *C&S Engineers, Inc. analysis 2019, FAA Airport Master Record, www.ngdc.noaa.gov*

Runway Strength

The 2016 Pavement Assessment and Pavement Management Plan (PMP) determined the strength and condition of the runways at SJT. The results of this study are summarized in **Table 3K** below. They show that all three of the existing runways at the Airport are cable of handling the future critical aircraft, the CRJ-900, which has a MTOW of 82,500 lbs. and a dual wheel main gear configuration.

TABLE 3K
Runway Strength and Condition

	Runway 18-36	Runway 3-21	Runway 9-27
Single Wheel Loading (Pounds)	70,000	70,000	70,000
Dual Wheel Loading (Pounds)	100,000	100,000	100,000
Pavement Classification Number	67	115	39

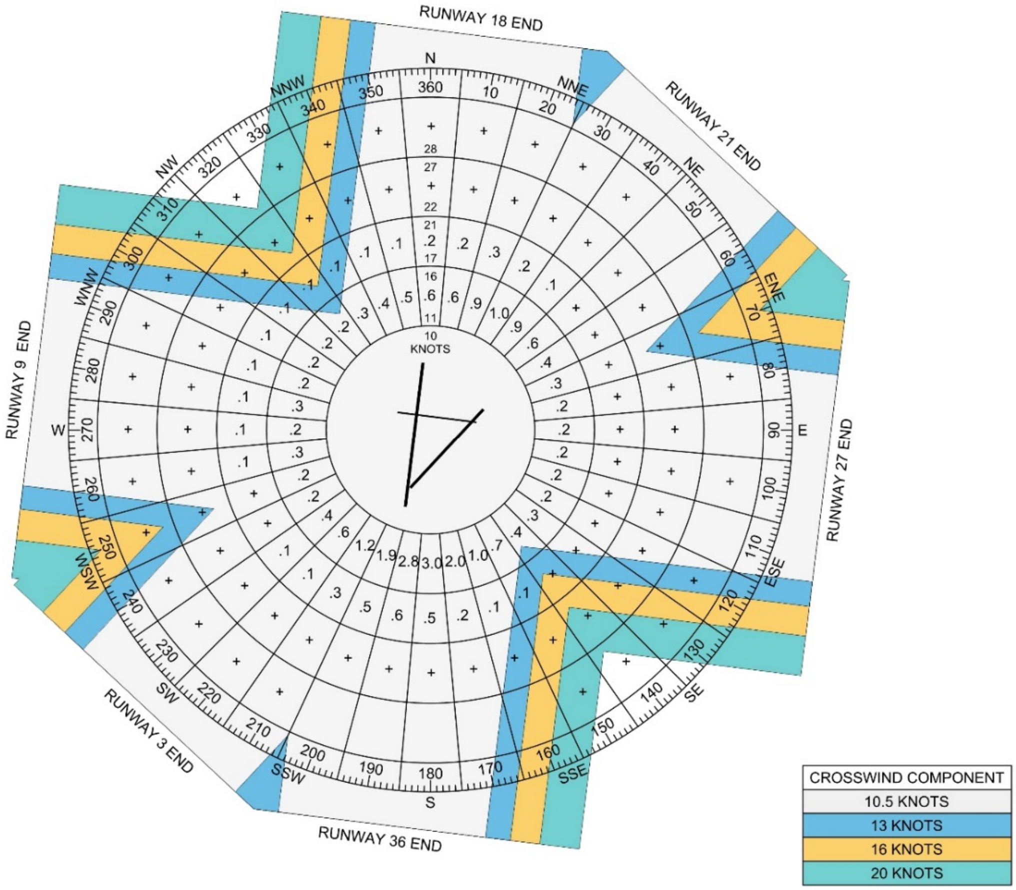
Source: *2016 Pavement Assessment and Pavement Management Plan*

Runway Orientation and Wind Coverage

The selected runway orientation is primarily a function of wind velocity and direction. As a general rule, the primary runway at an airport is oriented as closely as practicable in the direction of the prevailing winds. This allows aircraft to achieve maximum takeoff and landing performance. The crosswind component is the vector of wind velocity that acts at a right angle to the runway. Aircraft are tested by the manufacturer to determine the maximum crosswind component at which they can safely operate. Further, runway wind coverage is that percent of time in which operations can safely occur because acceptable crosswind components are met. The desirable wind coverage criterion for a runway system has been set by the FAA at 95 percent for any aircraft forecasted to use the airport on a regular basis. This means that 95 percent of the time, wind conditions will not exceed the maximum allowable crosswind component of the critical aircraft.

All-weather, VFR, and IFR wind roses were developed for the Airport using information gathered from the weather observations taken over a 10-year period from 2009 to 2018 at SJT. As shown on the wind rose depicted in **Exhibit 3E**, the combined all-weather wind coverage for the Airport is 99.96 percent for a 16-knot crosswind. Although the critical aircraft, the CRJ-700, falls within RDC C-III (which has an allowable crosswind component of 16 knots), the Airport also experiences a significant amount of General Aviation (GA) activity by smaller aircraft including those within RDC A/B-I, which has an allowable crosswind component of 10.5 knots. As shown in the exhibit, none of the existing runways are able to provide over 95 percent crosswind coverage at 10.5 knots. In order to accommodate the portion of the fleet with maximum crosswind components of 10.5 knots or less, a second runway is necessitated. If both runways 18/36 and 3/21 are combined the coverage at 10.5 knots is 96.91 % and sufficient to meet the demands of the GA fleet.

EXHIBIT 3E
All Weather Wind Coverage



Source: *NOAA Integrated Surface Database, C&S Engineers, Inc. analysis 2019*

TABLE 3L
All Weather Wind Coverage Percentages

Runway	10.5 Knots	13 Knots	16 Knots	20 Knots
Runway 18-36	94.72 %	97.14 %	98.89 %	99.63 %
Runway 3-21	90.34 %	95.38 %	98.60 %	99.65 %
Runway 9-27	78.51 %	86.64 %	95.62 %	99.03 %
All Runways Combined	99.46 %	99.85 %	99.96 %	99.99 %
Runways 18-36 and 3-21	96.91 %	98.52 %	99.47%	99.86%

Source: *C&S Engineers, Inc. analysis 2019*

Runway Thresholds

As discussed in the inventory chapter, the landing threshold for Runway 18 is displaced by 889 feet, leaving only 7,160 feet available for aircraft landing to the south. Since the threshold displacement does not affect the length of runway available for takeoff it also does not negatively impact the takeoff performance of either the existing or future critical aircraft, while operating on Runway 18. Additionally, the landing length analysis determined that the 7,160 feet available on Runway 18 is still sufficient to meet the needs of the CRJ-900. The potential to remove the displaced threshold and allow the entire length of Runway 18 to become available for landing will be looked at as a part of the alternatives analysis.

Declared distances are also in effect for both arrivals and departures on Runway 36. This artificially restricts the length of runway available for both take-off and landing to 7,160 feet.

Runway Protective Surfaces

Runway protective surfaces such as the Runway Safety Area, Runway Object Free Area, and Runway Protection Zone aim to protect aircraft, people, and property in the case of an aircraft deviating from its intended course while conducting conventional runway operations. The following sections outline the existing and future criteria for the runway protective surfaces at SJT.

Runway Safety Area

A Runway Safety Area (RSA) is a graded surface centered on a runway that is required to be free of all objects except for those that are 'fixed by function' such as runway lights and certain NAVAIDS. The purpose of the RSA is to protect aircraft in the event of an under-shoot or overrun from a runway during landing or take-off operations. The area must be able to support emergency vehicle operations and maintenance vehicles and is required to be graded to slope away from the runway at 1.5 to 5.0 percent. The width and length of an RSA depend upon an airport's RDC and approach visibility minimums. Meeting RSA requirements is one of the FAA's highest priorities in maintaining safety at the Nation's airports. **Table 3M** lists the Airport's existing and future RSA requirements.

TABLE 3M
Runway Safety Area Dimensions

Dimensions	Runway 18-36		Runway 3-21		Runway 9-27	
	FAA Standard	Meets Standard ?	FAA Standard	Meets Standard ?	FAA Standard	Meets Standard ?
Length Beyond Departure End	1,000	No	1,000	Yes	300	Yes
Length Prior to Threshold	600	No	600	Yes	300	Yes
Width	500	No	500	Yes	150	Yes

Source: *FAA AC 150/5300-13A, Airport Design, C&S Engineers, Inc. analysis 2019*

Runway 18/36 is the only runway with non-compliant Runway Safety Areas. The issue is due to the proximity of Knickerbocker Rd., approximately 560 feet to the north of the Runway 18 end. To mitigate this issue the Airport has displaced the Runway 18 threshold and put declared distances into effect which limit the amount of runway usable for takeoff and landing. These measures have brought Runway 18/36 into compliance with FAA standards, but at the cost of a reduced usable runway length.

Runway Object Free Area – ROFA

Similar to the RSA, the Runway Object Free Area (ROFA) must be free of objects except those required to support air navigation and ground maneuvering operations. The function of the ROFA is to enhance the safety of aircraft operating on the runway. The width and length of the ROFA depend upon the specific RDC and approach visibility minima. The ROFA does not have specific slope requirements, but the terrain within the ROFA must be relatively smooth and graded to be at or below the edge of the RSA. **Table 3N** notes the ROFA dimensions for SJT.

TABLE 3N
Runway Object Free Area Dimensions

Dimensions	Runway 18-36		Runway 3-21		Runway 9-27	
	FAA Standard	Meets Standard ?	FAA Standard	Meets Standard ?	FAA Standard	Meets Standard ?
Length Beyond Departure End	1,000	No	1,000	Yes	300	Yes
Length Prior to Threshold	600	No	600	Yes	300	Yes
Width	800	No	800	No	500	Yes

Source: *FAA AC 150/5300-13A, Airport Design, C&S Engineers, Inc. analysis 2019*

As with the RSA, the ROFA of Runway 18/36 must be reduced through the use of declared distances in order to achieve the required clearance from Knickerbocker Rd. Additionally the wind cone and segmented circle near Taxiway E and the wind cone adjacent to the Runway 18 threshold penetrate the ROFA. The wind cone near the Runway 21 threshold also penetrates the Runway 3/21 ROFA. Per FAA standards, they should be relocated out of these protected areas.

Runway Protection Zones

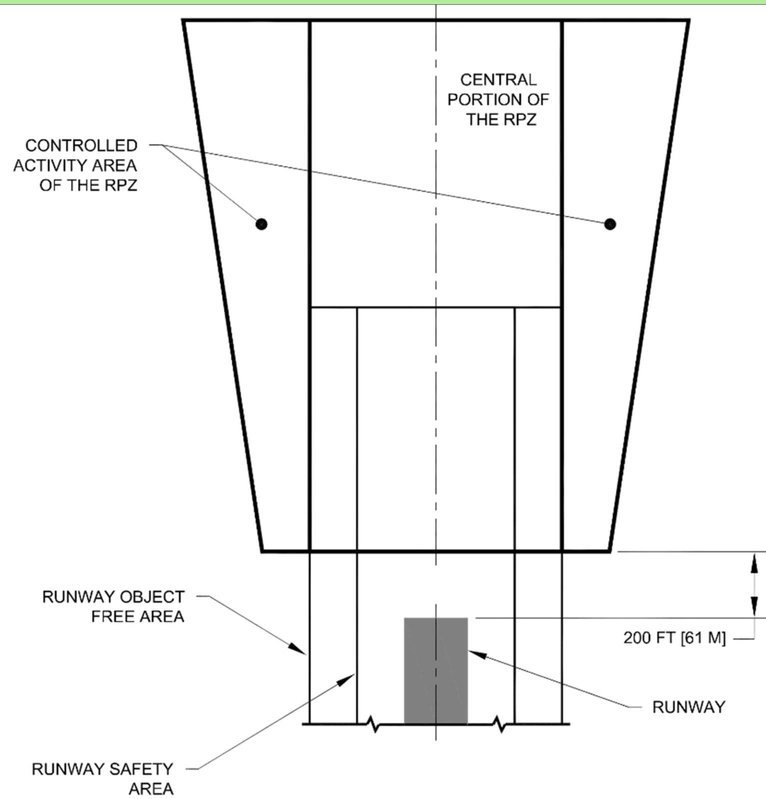
A Runway Protection Zone (RPZ) is an area centered symmetrically on an extended runway centerline. The RPZ has a trapezoidal shape and extends prior to each runway end. The RPZ is designed to enhance the safety of people and property on the ground by limiting and/or restricting the construction of certain structures within its bounds. This area should be free of land uses that create glare, smoke, or other hazards to air navigation. Additionally, the FAA requires that no vertical structures are constructed within the extents of the RPZ. This FAA guidance has become more restrictive in its most recent iteration, and thus some RPZs that were once in compliance with FAA guidance have become non-compliant due greater restrictions within the RPZ. The dimensions of an RPZ depend on each runway's RDC. **Table 3O** illustrates the RPZ requirements for each of the runways at SJT. **Exhibit 3F** depicts a typical RSA, ROFA, and RPZ.

TABLE 3O
Runway Protection Zone Dimensions

	Inner Width (ft.)	Outer Width (ft.)	Length (ft.)	Meet Standards?
Approach RPZ				
Runway 18	500	1,010	1,700	No
Runway 36	500	1,010	1,700	Yes
Runway 3	1,000	1,750	2,500	Yes
Runway 21	1,000	1,510	1,700	Yes
Runway 9	500	700	1,000	No
Runway 27	500	700	1,000	Yes
Departure RPZ				
Runway 18	500	1,010	1,700	Yes
Runway 36	500	1,010	1,700	No
Runway 3	500	1,010	1,700	Yes
Runway 21	500	1,010	1,700	Yes
Runway 9	500	700	1,000	Yes
Runway 27	500	700	1,000	No

Source: *FAA AC 150/5300-13A, Airport Design. C&S Engineers, Inc. analysis 2019*

EXHIBIT 3F
Example RSA, ROFA, and RPZ Dimensions



Source: FAA AC 150/5300-13A, Airport Design

Runway Incursion Mitigation

It is the goal of the FAA that airport runways and taxiways are designed in a manner that allows ease of operation for the pilots and minimizes the risk of confusion while taxiing or taking off and landing. The FAA has not currently designated any areas of the SJT airfield as hot spots or identified any areas as a part of the Runway Incursion Mitigation (RIM) Program. However, even though the FAA does not officially recognize any RIM locations at SJT, there still areas on the airfield that do not meet FAA design standards for runways. Most notable is the proximity of the Runway 18/36 and the Runway 3 end. This area is depicted below in **Exhibit 3G** and identified as "Area 1".

In order to reach the Runway 3 end a pilot must cross over Runway 18/36. This leads to confusion and also necessitates non-standard hold short markings. This combination is potentially hazardous and improvements to this area are discussed as a part of the Alternatives chapter in this report.

A second area of concern is the Runway 27 end. It has no taxiway access to the runway end and a departure on Runway 27 would require back taxiing on Runway 9-27 which is not recommended. The future decommissioning of Runway 9/27 will resolve this issue.

EXHIBIT 3G
Potential Areas of Concern

Note: At the time this exhibit was created, the current FAA Chart Supplement had not yet been updated to show the Taxiway C realignment. Old Taxiway C has since been demolished and a new, 90-degree connector has been constructed to the north of Runway 9-27. Additionally, Taxiway E has been demolished and a new, 90-degree connector has been constructed in the same location.

Source: FAA Chart Supplement, effective 28 MAR 2019 to 25 APR 2019

Taxiway Requirements

The taxiway system for the Airport should complement the runway system by providing safe access to and from runway and landside areas. Several different aspects of the taxiway system at SJT are discussed below.

Taxiway Width

In terms of taxiway design, based on FAA AC 150/5300-13A standards, the taxiways should be constructed to a minimum width of 35 feet to accommodate the TDG 2 CRJ-700 and CRJ-900. Currently the existing taxiway system is made up of a mix of 50 foot and 75-foot-wide taxiways. This exceeds the requirements for both the existing and future critical aircraft.

Taxiway Safety Area (TSA)/ Taxiway Object Free Area (TOFA)

The TSA and TOFA are centered on the taxiway or taxilane centerline and provide clearing standards that prohibit all objects except those whose location is necessary for air navigation or aircraft ground maneuvering purposes. The existing taxiways at SJT have been assessed for compliance with TSA and TOFA standards. Two areas have been flagged as potentially obstructing these surfaces. The first area is directly east of the AMCOM hangar. There is a section of pavement within the Taxiway A TOFA that appears to be used as an equipment parking area. The second area is the parking lot for the ARFF facility. The east side of the parking lot sits within the Taxiway A TOFA and should be kept clear of vehicles.

Run-up Areas

At SJT there is currently one designated aircraft run-up area. This area is located off of Taxiway A near the Runway 18 end. Run-up areas are used by pilots of general aviation aircraft to perform pre-takeoff procedures as well as to hold while waiting for clearance from ATC. Ideally, they should be marked clearly and designed so that they keep aircraft utilizing them completely clear of the active taxiway. The current run-up area is unmarked and does not provide sufficient room to keep aircraft using the area outside the TOFA for Taxiway A. Options for removal or improvements to this area are discussed in the Alternatives Chapter.

Problematic Taxiway Geometry

FAA requirements for taxiway design are intended to guide airports towards constructing and maintaining a safe, logical, and easily navigable network of taxiways. SJT has several areas that could be further optimized to better reach these intended goals.

Direct Access from an Apron to a Runway

As specified in AC 150/5300-13A, taxiways should not "lead directly from an apron to a runway without requiring a turn. Such configurations can lead to confusion when a pilot typically expects to encounter a parallel taxiway but instead accidently enters a runway." Currently Taxiway A leads directly from the apron onto the Runway 9 end.

High Energy Intersections

The FAA discourages against taxiways intersecting the middle third of a runway. This is known as a "high energy" intersection and should be kept clear because it is the point on the runway at which a pilot is least able to maneuver to avoid a collision. Taxiway D crosses Runway 18-36 in the middle third and potential realignments are considered as a part of the Alternatives Chapter.

Use of a Runway as a Taxiway

The FAA states that using a runway as a taxiway "can lead to confusion, wrong runway takeoffs, or runway incursions. A runway should always be clearly identified as a runway and only a runway." Runway 18-36 is the only runway at the Airport equipped with a full length parallel taxiway. To fully utilize Runways 9-27 or 3-21, aircraft may be required to taxi on a runway.

Taxiway Nomenclature

FAA Engineering Brief No. 99, *Taxiway Nomenclature Convention*, provides clarification on how to properly name taxiways. Adhering to the standards set forth in this document would require several taxiway name changes on the airfield. Taxiways A and B serve Runway 18-36 as both parallel taxiways and entrance/exit taxiways. It is recommended that when a taxiway makes a 90-degree direction change that the designation also change in order to avoid confusion.

Airfield Pavement

A *Pavement Prioritization Program Analysis* completed by KSA Engineers in April of 2018 assessed the condition of the runways and taxiways at SJT and set forth a recommended course of action to maintain the pavement at the Airport. This recommended plan is shown below in **Table 3P**.

TABLE 3P
Recommended Pavement Management Plan

Planning Period	Section Name	Recommended Action	Opinion of Probable Cost
Short Term (0-5 Years)	Runway 18/36	Crack Seal, Seal Coat, Re-Mark	$855,654.10
	Runway 3/21	Crack Seal, Seal Coat, Re-Mark	$845,396.20
Medium Term (6-10 Years)	Runway 18/36 Section 0	2" Overlay	$349,807.60
	Runway 18/36 Section 2	2" Overlay	$1,172,707.61
	Runway 9/27 Section 1	3" Mill and Overlay	$902,215.25
	Runway 9/27 Section2	Reconstruct	$748,605.15

Source: San Angelo Regional Airport, Pavement Prioritization Plan, KSA Engineers (2018)

Airfield Marking, Lighting, & Signage

Markings

The Inventory chapter describes the existing conditions of markings at SJT. A review of the existing conditions and the current FAA requirements found that the Airport is in compliance with all regulations and no recommendations for improvements are made. The existing markings will require to be expanded and updated as necessary in conjunction with any future airfield improvement projects.

Lighting

Chapter 1 – *Inventory*, describes the existing condition of airfield lighting equipment at SJT. Currently, the Airport has appropriate lighting equipment per requirements and no deficiencies exist. However, lighting will be analyzed in the alternatives chapter along with any proposed improvements to instrument approach minimums. Finally, any future improvements to or implementation of lighting equipment should feature LED technologies whenever able and practicable.

Signage

Chapter 1 – *Inventory*, describes existing conditions of airfield signage at SJT. As discussed in the previous section, changes should be made to the taxiway designations to reduce the risk of pilot confusion. Additionally airfield signage will need to be expanded and updated as necessary in conjunction with any airfield improvement projects.

Navigational Aids (NAVAIDS) & Weather Observation Equipment

Navigational Aids

The inventory chapter provides an overview of the existing navigational aids at the Airport. Currently SJT has the appropriate type of equipment required for the types of instrument approach procedures. However, it was found that all three of the wind cones were too close to their respective runways and penetrated the ROFA. A wind cone is not permitted to be placed within this safety area and will require relocation in order to comply with FAA standards.

Weather Observation Equipment

As discussed in the inventory chapter, the Airport is equipped with an ASOS near the south east boundary of the property. The ASOS provides both current as well as forecast conditions. The Airport has not had issues with the quality or accuracy of the reported data and at this time no changes are recommended to the ASOS. Compliance with the safety area surrounding the ASOS should be considered for any future development

Terminal Area and Landside Requirements

Terminal Area Requirements

The following section summarizes the passenger terminal facility requirements and related assumptions. These requirements were developed based on discussions with airport staff, knowledge of industry-wide trends, and published guidelines including International Air Transport Association (IATA's) *Airport Development Reference Manual*, FAA Advisory Circular (AC) 150/5360-13, *Planning and Design Guidelines for Airport Terminal Facilities*, and ACRP-25 *Airport Passenger Terminal Planning and Design*. **Figure 3H** explains how IATA determines level of service (LOS). "Optimum" LOS is the industry standard goal for developing terminal facilities.

EXHIBIT 3H
IATA Level of Service Standards

		Overdesign	Optimum	Sub-Optimum
		Excessive or empty space	Sufficient space to accommodate necessary functions in a comfortable environment	Crowded and uncomfortable
Overdesign	Overprovision of resources	OVERDESIGN	OPTIMUM	SUB-OPTIMUM Consider Improvements
Optimum	Acceptable processing and waiting times	OPTIMUM	OPTIMUM	SUB-OPTIMUM Consider Improvements
Sub-Optimum	Unacceptable processing and waiting times	SUB-OPTIMUM Consider Improvements	SUB-OPTIMUM Consider Improvements	UNDER-PROVIDED Reconfigure

Source: *Adapted from IATA Airport Development Reference Manual 10th Edition*

As seen in Exhibit 2DD in the forecast chapter, the peak hour passenger forecast from 2017 to 2037 only changes by 10 passengers (36-46). Therefore, terminal requirements were only generated for the baseline (2017) and the forecast outyear (2037). Requirements are generated for aircraft parking positions/gates, check-in positions, baggage screening and handling systems, passenger security screening, holdrooms, concessions, restrooms, inbound baggage and baggage claim. Secondary functions such as circulation and some "back of house" space needs were also considered in a quantitative analysis.

Aircraft Parking Positions

There are currently two aircraft parking positions, both are served with passenger boarding bridges. There is ample apron area adjacent to the terminal for remain overnight (RON) or inactive parking positions. Envoy Airlines currently remotes some of their RJs on this apron.

Currently, the only commercial service activity is five daily American Airline flights, increasing to 6 in the summer of 2019. These flights are spaced a few hours in-between so there are no overlaps. Also, three to four times a month there are charter airlines that use one gate position. There are ample aircraft parking positions to accommodate the current demand assuming power out. Pushback operations will be discussed in the alternatives chapter. **Exhibit 3I** depicts the current and future aircraft parking layout.

EXHIBIT 3I
Existing Aircraft Parking Layout

Source: *C&S Engineers, Inc. analysis 2019*

By the end of the planning horizon (2037) the peak hour operation is projected to be five. This is based on the assumption that the airport will attract additional airline service from a second commercial air-carrier. It is also assumed that the schedule will mimic American Airlines' current schedule. American Airlines is expected to increase aircraft size but is not expected to increase frequency of operations. Therefore, two gates are needed to accommodate the future levels of commercial service. On the days where there is a charter flight, or there are irregular operations and a third position is needed, there is ample apron area to park another aircraft between the two existing aircraft parking positions, and there is a lower-level holdroom to accommodate that flight. In conclusion, there are ample aircraft parking positions to accommodate the projected demand throughout the planning period.

Passenger Check-in/Bag Drop

Passenger check-in requirements are calculated using peak hour passengers, with an assumption that 50% of the peak hour passengers arrive at check-in at the peak 30 minutes of the peak hour. Peak hour passengers are split into different processing types such as traditional check-in, kiosk with no bag drop, or kiosk with bag drop. Within the traditional check-in, most airlines have a separate check-in area for premium passengers. While this is not the most efficient use of space, it is part of the airline's branding and business model, so it can be expected to remain.

At SJT, there are currently eight traditional check-in positions. American Airlines uses four positions. Three are for economy and one is for premium passengers. American Airlines also has two kiosks adjacent to the premium passenger line for those passengers who do not check a bag. There are no self-bag tag stations, although the two kiosks are equipped to do this function if that is desired in the future. For this analysis, the following assumptions were used:

TABLE 3Q Passenger Check-in/Bag Drop Assumptions
50% of passengers arrive in the peak 30 minutes of the peak hour[1]
85% of passenger use the traditional and premium check-in[2]
Traditional check-in processing rate is five minutes; Premium check-in is two minutes[1]
Kiosk check-in with no bags processing rate is two minutes[1]
Maximum desired wait time is 10 minutes[1]

Source: *[1]C&S Engineers, Inc. assumptions 2019, [2]American Airlines*

Based on the assumptions above, the total number of required check-in positions is three. To plan for moderate growth over the planning period, it is reasonable to assume a fourth position. American Airlines currently leases four positions. While the kiosks are not needed to meet the demand, they do offset demand on the traditional check-in area by 15% from passengers who are not checking bags.

The queue area is sufficient throughout the planning period, too. Currently American Airlines takes up about two-thirds of the queue area even though they only lease half of the check-in positions. If another airline starts service at the airport, American would likely need to reduce their queue area to accommodate the new entrant. It is recommended that American equally share the check-in area, queue area, and back of office space with the new entrant knowing that the new entrant carrier would likely have a similar aircraft type and schedule as American.

Currently, three to four times a month, charters are processed through the existing check-in area and these charter flight schedules can overlap with American Airlines schedules. In the existing condition, the check-in area is sized appropriately to accommodate this occurrence. However, if a new entrant similar to American's operation is introduced and has a matching flight schedule, the check-in area will not be able to process the charters at the same time. The simplest fix would be to reschedule the charter's flight operations outside the commercial service airline schedule. Also, because there is no room to expand the check-in area, the airport would need to support a common use check-in platform to toggle back and forth between the commercial service airlines and charter flights.

Explosive Detection System (EDS) Baggage Screening

EDS baggage screening equipment and staffing are typically determined by TSA. However, EDS screening requirements can be calculated by dividing the EDS checked baggage screening equipment processing rate by peak hour checked bags. Per the TSA guidelines, processing rates for Stand Alone checked baggage EDS screening equipment range from 100-200 bags per hour.

According the American Airlines, the only commercial carrier operating at the airport, 85% of passengers check one bag. Therefore, there are approximately 31 peak hour checked bags in the Baseline scenario (2017), and 40 checked bags by the end of the planning horizon (2037). In either scenario, the number of checked bags is well below the estimated capacity of the current system. In fact, there is capacity to process additional bags if American wanted to add more peak hour flights, or if another airline were to add service in the peak hour.

Outbound Baggage

Outbound baggage is sorted and loaded onto airline carts for each departing flight. This function occurs behind the check-in and baggage screening area. Typically, baggage makeup requirements are calculated in terms the number of carts required to accommodate aircraft in the departure peak and the area needed for to accommodate the carts, with an allowance for baggage tug circulation. Typically requirements are based on size of the aircraft (e.g. ADG-III aircraft is 1.0 equivalent gate, but smaller aircraft like a large regional jet is 0.5 equivalent gates or larger aircraft like a ADG-IV is 1.2 equivalent gates) either during the peak period or maximum that can be accommodated at the gate. The latter was used for this analysis.

The outbound baggage makeup area is adequately sized to accommodate three concurrent departures which is the maximum number based on the aircraft parking apron, noted in the section above. Three large regional jet departures would require four staged carts. Assuming the carts are 5 feet by 10 feet then the required baggage belt length would be 20 feet or 40 feet, depending on the cart orientation. With some maneuvering space, 50 feet of baggage belt length is needed to accommodate this scenario. The current baggage belt length is approximately 50 feet. The only scenario that would create congestion is three different airlines departing simultaneously, one at each gate. This scenario is unlikely and could be reconciled by staggering the flight schedules of the various airlines. The interior area of the baggage makeup may be congested in peak periods because of the emergency exit stair adjacent to the makeup device.

Passenger Security Screening

There is one security checkpoint lane and queue area adjacent to the check-in area. Passenger security checkpoint lane and area requirements are calculated based on the peak hour passenger volume. Typically, the processing throughput for a standard passenger security checkpoint ranges from 120-180 passengers per hour. For TSA PreCheck lanes, the processing rate ranges from 200 to 300 passengers per hour. TSA is developing biometric solutions that could increase these throughputs further, in the future. These processing rates are also based on standard security checkpoint layout designs.

The projected peak hour passenger volume in 2017 is 36. The projected peak hour passenger volume in 2037 is 46. Therefore, one passenger security checkpoint lane will accommodate the projected demand throughout the planning horizon. Even though the airport has a non-standard layout, the size of the security checkpoint and queue is sufficient. The only potential impact to the security checkpoint would be the addition of a PreCheck lane. However, given the small passenger volume and the layout of the security checkpoint, an additional lane is not likely; the few PreCheck passengers can be accommodated through the standard checkpoint lane.

Holdrooms and Boarding Gates

There are two common industry accepted methods to calculate holdroom requirements. One is to apply a standard area to a gate based on the maximum aircraft size allowable at that gate. The other is to estimate the demand based on the estimated gate requirements in the peak hour of operation. The former was chosen for this analysis because there is only one carrier currently operating, but the Airport has requested the master plan team review the recent terminal improvements to confirm it can accommodate future growth, including other airlines. The way the airport is currently operated, there are two gates with boarding bridges. As shown in **Figure 3I** above, there is area on the apron to park up to three large regional jets simultaneously. As shown in **Table 3R**, the existing holdrooms can accommodate two gates. A simultaneous 3-gate operation or a larger regional jet boarding from the lower level would cause congestion.

TABLE 3R
Holdroom Requirements

	Existing	2 Gate Scenario	3 Gate Scenario
Holdroom Requirements	850 SF (Lower Level) 3,000 SF (Upper Level) 3,850 SF (Total Existing)	2,800 SF	4,200 SF

Source: *C&S Engineers, Inc. analysis 2019*

Concessions

Concession areas provide an improved passenger level of service, create a sense of place for the airport, and provide an opportunity for increased revenue generation. Currently, the Airport is home to two restaurants, both of which are pre-security. A vending machine is the sole food option in the secure area.

Typically, to estimate the size of the future area that would provide the airport with a reasonable program, demand is projected using industry standard planning assumptions. As stated in ACRP 54, *In-Terminal Concessions*, for Airports under 1 million enplanements, approximately 14.7 SF of concessions space was calculated per every 1,000 annual enplanements; 10.6 SF for food and beverage, .4 SF for convenience retail, and 3.7 SF for specialty retail. 70 percent or more of the total concessions space should be allocated post-security, and 30 percent or less for pre-security. Often at smaller airports, there is a desire to have one pre-security restaurant that employees or other tenants can use. Depending on the commercial service departure profiles, it can be difficult for a concessionaire to staff post-security concessions. The commercial flights at SJT are currently once every few hours and there isn't enough volume of passengers to justify inventory or staffing a post-security concessions. If future flight schedules included more departures in a concentrated period, then a small area may be justified.

Based on the assumptions above, the Airport needs approximately 900 total SF (2017) and 1,150 total SF by the end of the planning horizon (2037). The Airport has more than enough pre-security food and beverage areas to accommodate the future demand. The Airport may consider a small retail shop pre-security in addition to the two existing restaurants. The post-security area is below the requirement, but given the very low passenger volumes, it is understood why there are no larger spaces. A small, non-cooking, coffee/bar with snacks might be appropriate post-security.

On average, an additional 25 percent is typically allocated for food and beverage storage, and an additional 20 percent should be added for retail storage, away from the immediate concessions area. Applying these additional percentages shows that all concessions areas seem to have adequate storage area.

Inbound Baggage Makeup and Baggage Claim

Baggage claim is located to the left of the passenger check-in area and has one flat plate device. Baggage claim linear frontage requirements are calculated based on the following assumptions.

TABLE 3S Inbound Baggage Makeup and Baggage Claim Assumptions
85% of passengers check one bag[1]
An additional 30% load is added to passenger volumes to account for "meeters and greeters"[2]
1.5 linear feet is needed to accommodate one person comfortably[2]

Source: *[1]American Airlines, [2]C&S Engineers, Inc. assumptions 2019*

The baseline scenario (2017) has a peak hour passenger volume of 36, so baggage claim linear frontage requirement is 34 feet. By the end of the planning horizon (2037) the peak hour passenger volume is 46, and the baggage claim linear frontage requirement is 44 feet. The existing linear frontage is approximately 47 feet. Therefore, in the current, one airline scenario, the baggage claim area is sufficient to accommodate the projected demand. However, in the scenario where there are two airlines, with flights arriving around the same time, the baggage claim belt and pick up areas would become congested. Given the size of the aircraft, this would only be a short period of time.

Passenger baggage from arriving flights is unloaded and tugged to the inbound baggage handling area in the back-of-house side of the baggage claim. There is one inbound belt, which is directly connected to the one flat-plate baggage claim belt. Requirements for inbound baggage makeup area are calculated in a similar manner as outbound baggage make up, except that inbound typically has all of the bags from a small aircraft at one time, where outbound make up is more dispersed, based on when passenger arrive and check-in. Inbound baggage linear frontage is approximately 50 feet.

Because of the building layout, it is assumed that baggage carts are parked parallel to the belt. Therefore, the belt can have two to three baggage carts parked adjacent to it at any one time. Two to three carts are more than enough to accommodate the project demand through the planning horizon.

In a future scenario with two different airlines with simultaneous arriving flights, the inbound baggage area would be congested, similar to baggage claim. However, this would only occur in the peak period (10-15 minutes) or the airlines could slightly modify schedules to avoid the congestion.

Restrooms

Restrooms are an important, but often overlooked element at an airport. They are not one of the major functional terminal areas but are often the area that receives the most passenger complaints when surveyed. Per ACRP Report 25, one way restrooms requirements are calculated for terminal buildings is 2.0 to 2.5 SF per peak hour arriving and departure passengers and well-wishers/meeters and greeters. Because of the small peak hour volume, even including added meeters and greeters, the existing restrooms can accommodate the projected demand. In this case, the actual building occupancy, governed by local building code, is more appropriate to apply, based on the total person load, not just departing or arriving passengers.

Circulation

Circulation is typically split into three areas: public circulation, Federal Inspection Station (FIS) sterile arrivals circulations, and non-public walkways. Minimum clear circulation widths for public areas is typically 25 feet between major functional elements. For a concourse, the minimum width is 20 feet for a single loaded concourse, and 30 feet for a double loaded concourse without a moving walkway. For FIS sterile corridors, the minimum width standard is 15 feet for a single direction flow. For non-public areas, such as back-of-house spaces, office space, etc., the width is determined by the function (i.e. moving supplies in a corridor near a loading dock) and local building codes. SJT is unique because of the small volume of commercial passenger traffic. These industry standard rules don't really apply. If the future commercial flight schedule had three simultaneous departures or arrivals (two commercial and one charter) there could be some congestion, but only for 10-15 minutes. Generally, based on field observations, and the analysis that the projected peak hour demand passenger volume is only expected to rise by 10 passengers by 2037, there are no issues to address with circulation.

Office Space

In the terminal building, this includes non-public areas such as airline ticket offices (ATO), TSA offices, baggage service offices (BSO), rental car offices, general storage space, and airport offices. There is no official industry standard calculation to determine required office space. The area requirements are generally determined by the airport or the tenant (concessions, TSA, airlines, etc.). Through field observations, discussions with staff, and review of the terminal layout plan, reasonable office space is available throughout the building.

American Airlines occupies one half of the ATO space and uses much of the other half for storage. If another airline starts service, American would have to relocate their storage so the airport can accommodate the other carrier. There should be ample space for both airlines assuming that they are willing to share a common break room. Rental cars have ample office space. The Airport reports that TSA has sufficient office space by the baggage and passenger checkpoint, and there are no airline BSOs. If American or a second airline starts service, space for individual BSOs should be considered by the Airport. Otherwise, office space seems to be appropriate for an airport of this size.

Second Commercial Service Airline

During the master plan process, the re-introduction of additional service from a second commercial airline was found to be realistic and an additional forecast scenario was developed to account for this. This scenario assumes that the second commercial service airline would mimic the current American Airlines schedule and would affect the peak hour passenger volume in the out-years, increasing from 46 (in the Baseline) to 101. This increase would impact the requirements of some functional areas more than others. The impact of a potential second commercial service airline was mentioned within the various functional areas described above, but given that this reality is more likely sooner rather than later, additional summary below further explains some of the issues that may result.

In general, the number of check-in positions, security checkpoint lanes, and aircraft parking positions is sufficient to accommodate the second commercial service airline. In addition, the checked baggage screening rate, of 100-200 bags per hour is sufficient to accommodate the second commercial service airline. With the sizable pre-security restaurants and restrooms there is ample space to accommodate passengers. It is recommended that charter service is accommodated in the off-peak or completely outside the terminal as the existing facility could not accommodate two commercial services airlines and a charter at the same time.

The following areas will likely experience congestion with the addition of the second airline operating on a similar schedule as the existing service:

- Check-in queue area
- Security checkpoint queue areas
- Outbound baggage makeup
- Holdrooms
- Inbound baggage makeup
- Baggage claim area.

While the number of check-in positions is sufficient to accommodate a second airline, the queue area will be congested. Today, American Airlines occupies approximately two-thirds of the check-in queue. When a second airline is added, it is assumed they will split the area equally, but that could result in the queues extending outside of the designated queue area. A charter flight cannot be accommodated if two airlines are operating in the existing check-in area unless it is in an off-peak time and the airport is on a common use check-in platform.

Typical security checkpoint lanes can accommodate 120-180 passengers per hour. So even on the low end, the existing lane can accommodate the additional demand. However, given the non-standard checkpoint layout, it is likely that if an additional airline is added during the peak period, the security checkpoint queue would expand into the terminal lobby. If a charter operation occurred at this same time, the security checkpoint would be overwhelmed. Another scenario that could cause congestion at the security checkpoint is based on the unique characteristics of the airport. Because there are very limited post-security concessions, passengers may be inclined to wait in the pre-security restaurants or lobby before their flights, and not enter the security checkpoint until 30-40 minutes prior to their flight. This could cause significant congestion in the lobby and checkpoint queue as typically the flow of passengers is staggered based on the passenger arrival curve.

The outbound baggage makeup area would be at full capacity in a second airline scenario. The baggage belt length is sufficient, but the overall area would be congested due to both airlines using one belt and the emergency exit stairway adjacent to the area. If a charter flight operated simultaneously with the commercial service airlines, the outbound baggage make up area would be overwhelmed.

Holdrooms are sufficient to accommodate two commercial service airline departures, one per each gate with a boarding bridge. If there was a third departure in the same time period, or if an aircraft is delayed, the holdrooms would become congested, even if the third holdroom area at the ground level was utilized. Additionally, if a charter flight occurred at the same time as the two commercial service flights, the holdrooms would be overwhelmed.

Of all functional areas, the inbound baggage make up and baggage claim areas are the most challenged in the second commercial service airline scenario. These areas would be at capacity by the end of the planning period. If a second commercial service airline is added in the near-term, the demand would double and immediately exceed capacity. These areas could not function if a charter was added during this peak period. Also, there are currently no baggage service offices (BSO), which is typical for a small airport. However, if a second commercial service airline is added, it is recommended that a BSO area is programed. Ways to accommodate the demands resulting from the second commercial service airline scenario will be addressed in the alternatives analysis chapter. The viability of accommodating the added demand within the existing terminal building versus constructing a new terminal will be evaluated.

Landside Requirements

Cargo Facilities

Currently FedEx and UPS are the only cargo operators at the Airport. FedEx leases approximately 10,000 SF of Hangar No. 204. They use this space to offload aircraft, sort cargo, and load trucks. The UPS operation takes place entirely on the apron and they have no permanent facilities at the Airport. The existing cargo area is deemed adequate for the size of the operation, although local FedEx representatives indicate the existing location can be operationally difficult.

Fuel Facilities

All aircraft fueling services at SJT are provided by Ranger Aviation and Skyline Aviation — the two FBOs at the Airport. Between the two, a total of 35,000 gallons of Jet A and 24,000 gallons of 100LL fuel is stored in four above-ground storage tanks. In addition to the fuel storage tanks, several fuel trucks operate at the Airport as follows:

Ranger Aviation

- 5,000 Gal. Jet A with additives (Leased from Avfuel)
- 2,500 Gal. Jet A with additives (Leased from Avfuel)
- 1,000 Gal. 100 Low-lead (Owned by Ranger)

Skyline Aviation

- 3,000 Gal. Jet A (Leased from World Fuel)
- 1,200 Gal 100 Low-lead (Leased from World Fuel)

Fuel storage requirements at SJT were calculated by determining the average number of projected daily turbine and piston operations throughout the planning period. Ratios of 10 gallons of Jet A per turbine operation and 4.2 gallons of 100LL fuel per piston operation were applied to determine two-week fuel storage requirements, as well as an applied 10 percent increase adjustment to accommodate peak periods. **Table 3T** illustrates the projected average and peak fuel demand for SJT for a two-week period throughout the 20-year planning horizon.

TABLE 3T
Estimated Aircraft Fuel Demand (Two-Week Period)

Year	Average Daily Piston Ops.	Average Daily Turbine Ops.	Average Demand (gal.)		Peak Demand (+10%) (gal.)	
			100LL	Jet A	100LL	Jet A
2017	121	87	7,115	12,180	7,826	13,398
2022	124	90	7,291	12,600	8,020	13,860
2027	127	92	7,468	12,880	8,214	14,168
2037	133	96	7,820	13,440	8,602	14,784

Note: *Existing average daily piston and turbine operations were estimated using FAA Air Traffic Activity Data System (ATADS) and Traffic Flow Management System Counts (TFSMC) data for the year 2017; forecasted average daily piston and turbine operations were estimated using the forecasted total annual operations within each planning period. Historic fuel sales data from the FBOs were not available for analysis.*

Sources: *FAA ATADS, 2017; FAA TFMSC, 2017; Landrum & Brown, Draft Forecasts, San Angelo Regional Airport Master Plan, C&S Engineers, Inc. analysis 2019.*

Based on the analysis illustrated in Table 3T, SJT's existing fuel storage capacity and supply will likely meet demand throughout the 20-year planning timeframe, and thus construction of additional fuel storage equipment is not anticipated. The FBOs should continue to maintain and service their fuel storage tanks and equipment in accordance with required standards set forth by the Airport, the City of San Angelo, as well as any federal or state regulatory agencies.

There has been some discussion between both FBOs and airport management about constructing a consolidated fuel farm wherein each FBO could maintain their own tank(s). Should the Airport wish to move forward with this concept, potential locations will be evaluated and presented during the Alternatives Analysis chapter.

Access and Parking

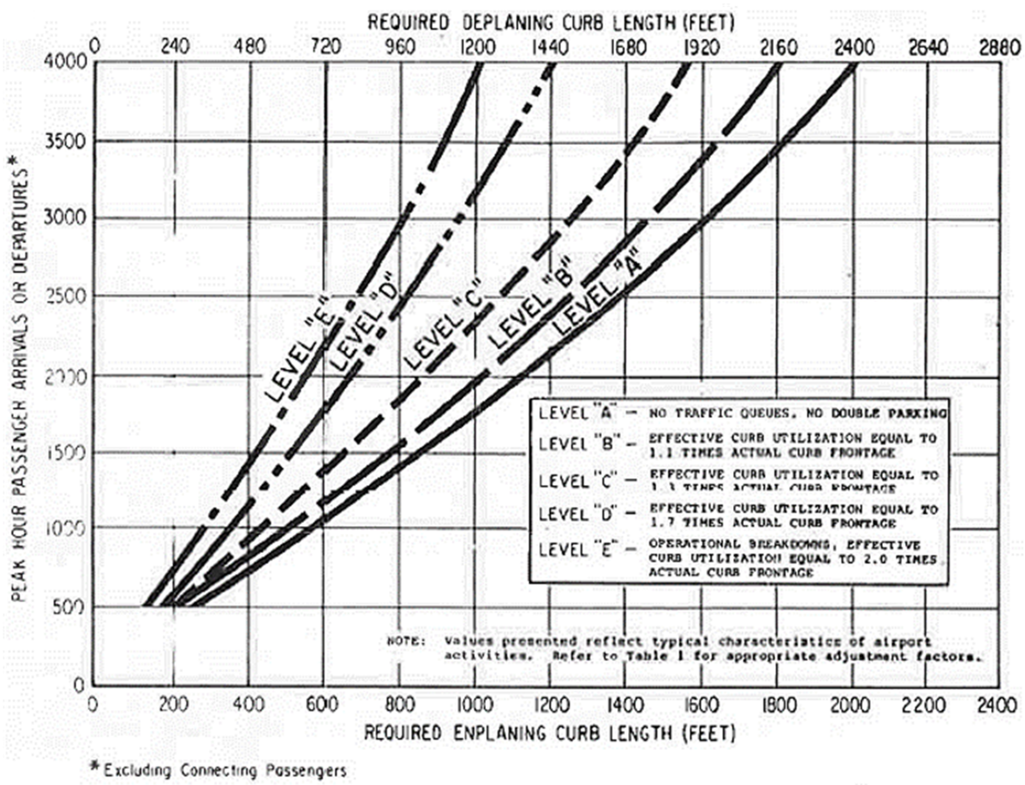
Based on feedback from the technical and planning advisory committees (TAC/PAC), there are no existing or future access roadway concerns regarding the capacity of the roadways to accommodate future traffic generated by the Airport based on the 20-year forecast. Reary Boulevard and Knickerbocker Road north of the main Airport entrance each consist of two travel lanes in each direction. Terminal Circle consists of two travel lanes around the public parking facilities and adjacent to the terminal. While Hangar Road, Stewart Lane, and Knickerbocker Road south of the main Airport entrance consist of one lane in each direction. There are no existing or future operational concerns regarding traffic based on Airport operations.

While the TAC and PAC identified easy access to and from the Airport as a strength, they also noted concern regarding lack of secondary access to the Airport along with delays associated with the railroad crossing on Knickerbocker Road. The most time efficient route from San Angelo to the Airport is via Knickerbocker Road which includes a railroad crossing and a bridge across Lake Nasworthy. There are other available routes: via US Route 87 and US Route 277 to Country Club Road to South Concho Drive then Knickerbocker Road (around Lake Nasworthy) or via US Route 277 to Farm to Market Rd 584 that becomes the southern approach to the Airport on Knickerbocker Road. Wayfinding signage could be provided on these roadways and these secondary access routes could be noted on the website to inform the traveling public of these options.

The data required to conduct a full analysis of the curb area operations (peak hour vehicle counts by type) is not available. Figure 3 of Transportation Research Record 840 provides a method of determining length of curb frontage needed based on peak hour enplaning/deplaning passengers and the desired LOS. (See **Exhibit 3J**).

EXHIBIT 3J
Transportation Research Record 840

Figure 3. Suggested Method for Estimating Curb Frontage Needs



Source: C&S Engineers, Inc. analysis 2019

SJT currently has 300 feet of curb frontage. Since arrivals and departures share the same area, to be conservative, it is assumed they each have 150 feet of curb frontage available to them at any given time. Based on Figure 3 of Transportation Research Record 840, the ratio of feet of curb available per enplanement is approximately 0.42 to maintain a LOS C and 0.49 for deplanements. Therefore, assuming there is 150 feet available for enplanements and 150 feet available for deplanements, the curb frontage at SJT could theoretically handle approximately 360 peak hour enplanements at a LOS C and approximately 300 deplanements. Since the forecast indicates only 46 enplanements and 46 deplanements during the peak hour in 2037, the existing 300 feet of curb frontage at SJT is expected to accommodate future demand at an acceptable LOS.

There do not appear to be any issues or concerns with curb frontage usage. Taxis and transportation network companies (TNCs) like Uber/Lyft do use the curb, but given the free and easily accessible parking lot adjacent to the terminal, double parking or other congestion on the curb frontage is not typically observed.

The TAC and PAC also provided favorable comments regarding the public parking facilites at SJT noting that they are easy to access and free to the public. There are currently 103 short-term spaces, 242 long-term spaces, 76 spaces dedicated to rental car operations, and 115 overflow spaces. Based on an ACRP 25, *Airport Passenger Terminal Planning and Design, Volume 1: Guidebook*, rule-of-thumb range of parking supply that should be provided per enplanements, the Airport has more than enough parking to accommodate their existing and future demand. ACRP Report 25 also indicates that approximately 25 to 30 percent of public parking spaces should be dedicated to short-term use. This would mean that of the 460 spaces available to the public, 115 to 138 spaces should be dedicated to short-term parking. Since the Airport also has two restaurants within the non-secure areas of the terminal that also generate short-term parking demand, it is recommended that the higher number of spaces (approximately 135-140 spaces) are dedicated to short-term parking.

It is assumed that employee parking and rental car parking demand are currently being accommodated by existing facilities and that there are no concerns based on the forecast for the 20-year planning period. There were no comments from the TAC or PAC regarding any weaknesses or threats regarding employee or rental car parking facilities.

Airfield Perimeter Fencing, Gates, and Security

Perimeter Fencing/Gates

The primary function of airport fencing is to restrict inadvertent and intentional unauthorized entry to the airfield by individuals or wildlife. The Airport currently has fencing and access control measures in place that provide a layer of security and safety for its users and the public. As discussed in chapter one, SJT's property is entirely enclosed by a 6-foot high, chain-link fence. According to a site visit and as illustrated on Exhibit 1J, there are 11 automatic gates with access control systems, and 27 manual gates at various locations along the fence line.

Overall, the perimeter fencing at the Airport, as well as the vehicle and pedestrian gates, are in good, functional condition. However, several comments made during the initial TAC meeting at the onset of the airport master planning process included, "the perimeter fencing and gates are confusing and difficult to maneuver" and that there are "too many gates/access points." One recommendation for the Airport would be to conduct an assessment of all gates/entry points in order to identify redundancies and/or inefficiencies with existing locations of both manual and automatic gates. The outcome of the assessment may lead to a reduction in gates, or an increase or enhancement to signage, or both.

A Wildlife Hazard Assessment (WHA) was published for the Airport in 2012. Among other valuable findings, a WHA informs the Airport where vulnerabilities are present in the perimeter fencing that allows wildlife to breach the perimeter and suggests measures to correct or prevent future breaches. Because wildlife was also a concern of TAC members, Airport personnel should continue to closely monitor any areas identified in the WHA where wildlife have previously, or continue, to breach perimeter fencing to ensure the airfield remains safe and secure from any unauthorized intrusions, whether animal or human.

Security

Chapter One indicated that SJT is designated as a Class II airport under 14 CFR Part 139 requirements and must maintain a current airport operating certificate at all times as long as commercial airline activity takes place at the Airport. Likewise, SJT is required to have an airport security program in place in accordance with 49 CFR Part 1542 – *Airport Security*.

According to airport management and observations during the inventory site visit, SJT currently meets all requirements of 49 CFR Part 1542. SJT should continue to maintain their airport security program in order to remain in compliance with 49 CFR Part 1542, as well as adhere to the general rules contained in Part 1540 – *Civil Aviation Security: General Rules.*

General aviation security measures are not mandated by the federal government; however, many GA airports provide some varying degree of security for their users, especially in busy urban areas, and even more so since the events of September 11, 2001. SJT is considered a commercial service airport, although GA and military operations comprise the majority of the activity at the airport. As mentioned above, the Airport already conforms to and meets federally mandated security measures through its Part 1542 airport security program. However, there are several programs worth noting designed to increase general aviation security.

The Aircraft Owners and Pilots Association's (AOPA) Airport Watch Program created an around-the-clock telephone hotline answered by federal authorities for pilots and other airport users to report suspicious activity at GA airports. Usually, if requested, AOPA representatives can provide informational materials and signage to airports/FBOs on the Airport Watch Program. Furthermore, the Transportation Security Administration's (TSA) *Security Guidelines for General Aviation Airport Operators and Users* (Information Publication A-001, Version 2), provides a set of federally-endorsed recommendations to enhance security for municipalities, owners, operators, sponsors, and entities charge with oversight of general aviation airports. The TSA's guidance provides nationwide consistency with regards to security at general aviation facilities, as well as a rational method for determining when and where security enhancements may be appropriate based on the airport's own self-assessment of its operational facility. The guidelines offer extensive suggestions and proven best practices for the airport operator, sponsor, tenant and/or user. It is recommended that the City of San Angelo and Airport management review the TSA *Security Guidelines* in order to assess if SJT could benefit from any additional security enhancements on the airfield. Periodic reviews of this document and the self-assessment should also be conducted.

General Aviation Requirements

General aviation operations make up the majority of activity at SJT, thus ensuring these activities can be accommodated is essential to the continued success of the Airport. GA activity at SJT depends on the following facilities – storage hangars, aircraft parking apron, and the FBOs, who in essence serve as the GA terminals on the airfield. As previously described in Chapter One – *Inventory*, GA facilities at SJT are located to the north and south of the commercial service terminal building and apron. The Airport leases hangars and offices to individual tenants in these areas, including two FBOs – Ranger Aviation and Skyline Aviation. The FBOs typically cater to transient GA aircraft, although based aircraft tenants may use their facilities and services in some capacity or another, for fuel or maintenance, for example.

The GA facility requirements for SJT were determined using the forecast GA annual operations and existing and forecast based aircraft fleet mix. The forecast annual GA operations (see **Table 2W**) established the peak month and design day/hour operations, which was used to estimate the required common space needed for GA pilots and passengers within the planning period. Likewise, the existing and forecast based aircraft fleet mix (see **Table 2V**) provided requirements for hangar and apron storage within the planning period. However, it is important to note that the hangar and apron requirements herein do not take into consideration the five Envoy Air commercial jet aircraft that currently utilize the North Apron because they are not considered general aviation aircraft. Thus, five turbine aircraft were excluded from the 2017 baseline GA facility requirement calculations. Additionally, it is assumed that five commercial jet aircraft will make up the total turbine-based aircraft at the Airport throughout the planning period, and thus were also excluded from calculations to determine future based GA aircraft needs.

Aircraft Storage

Aircraft Hangars

Hangar requirements for a GA facility are a function of the number of based aircraft, the type of aircraft to be accommodated, owner preferences, and area climate. Furthermore, it is common when calculating the hangar size needs of a facility to use an average size requirement for the various types of aircraft, meaning that each type of aircraft will require a different amount of space (usually measured in square-feet) within a specific type of storage facility, e.g. T-hangar, single-aircraft box hangar, or large multi-aircraft conventional hangar. Industry standards regarding facility space for GA based aircraft were developed using guidance from ACRP Report 113, *Guidebook on General Aviation Facility Planning*, which includes recommended space requirements unique to the type of aircraft engine typical for most general aviation aircraft. The space requirements were modified per industry standards for the turbine aircraft to better represent the typical aircraft that are currently stored in hangars at SJT. **Table 3U** illustrates the average aircraft space requirements based on aircraft type for the Airport.

TABLE 3U
Average Aircraft Space Requirements

Aircraft Storage Type	Space Required (SF)
Conventional Hangar	
Single-Engine Piston	1,200
Multi-Engine Piston	1,400
Turboprop/jet[1]	10,000
Rotorcraft	1,800
T-Hangar/Single-aircraft Box Hangar	
Single-Engine Piston/Multi-Engine Piston	1,400

Note: 1) Based on the average SF of the Cessna Citation family of jets currently based at SJT.
Source: C&S Engineers, Inc., analysis 2019

The average space requirements for the various aircraft in the Airport's based aircraft fleet mix was applied to the based aircraft forecasts to estimate hangar area requirements for each hangar type. Since the exact storage location for each based aircraft was unavailable for analysis, assumptions were made that estimate the location of each based aircraft at SJT today. **Table 3V** displays the assumptions made regarding the type of storage needed for each type of based aircraft at the Airport. The existing based aircraft data provided by airport management, along with the estimate of some of the current aircraft storage conditions as they exist on the airfield today, were used to develop these assumptions. Finally, using these averages and assumptions, combined with the forecasted fleet mix, **Table 3W** depicts the calculated demand requirements for hangar space at the Airport for each of the planning periods.

TABLE 3V
Based Aircraft Storage Assumptions

Aircraft & Storage Type	% of Based Aircraft Fleet Using Storage[1]
Single-Engine Piston	
T-hangar/Single Box	55%
Conventional Hangar	40%
Parking Apron	5%
Multi-Engine Piston	
T-hangar/Single Box[2]	0%
Conventional Hangar	80%
Parking Apron	20%
Turboprop/Jet	
Conventional Hangar	95%
Parking Apron	5%
Rotorcraft	
Conventional Hangar	100%

Notes: *[1]Assumes the percentage of the based aircraft fleet using each type of storage remains constant over the planning period. [2]According to airport management, the existing single-box/T-hangars are not large enough to accommodate a ME piston aircraft, but the demand to store ME piston aircraft in single-box/T-hangars does exist should these hangars become available.*

Source: *San Angelo Regional Airport; C&S Engineers, Inc. analysis 2019*

TABLE 3W
Existing and Forecasted Hangar Needs

Hangar Type (SF)	2017 (Existing)	2017 Forecasted	2022	2027	2037
Conventional (Corporate/Executive)1	481,000[2]	510,000	533,800	556,800	580,400
T-hangar/Single-Aircraft Box	94,000[3]	79,800[4]	82,600	84,000	91,000
Total Hangar Area	**575,000**	**589,800**	**616,400**	**640,800**	**671,400**
Estimated Total Aircraft Utilizing Hangars[4]	N/A	161	168	173	183

Notes: *[1]Includes conventional hangars leased to GA tenants exclusively. [2]Total square feet (SF) excludes Hangar No. 102 (80,000 SF) and Hangar No. 108 (42,000 SF) which are in poor and unleasable condition for aircraft storage at this time and excludes Hangar No. 313 which is privately owned. [3]Actual SF not available, thus hangars were measured using aerial imagery and are approximate in size. [4]Although the reported existing 2017 SF varies from the estimated 2017 baseline SF; the calculations indicate demand for T-hangars and/or single-aircraft box hangars does exist within the planning time frame.*

Source: *C&S Engineers, Inc. analysis 2019*

Currently, according to airport management and tenants, all existing hangars (excluding No. 102 and No. 108 – the old AMCOM hangars) at SJT are currently leased, and a wait list for hangars is in effect. Likewise, the Airport has in recent months received numerous inquiries from several companies and individuals wishing to relocate their aircraft from another airport in the region to SJT should hangar space become available. The results of the hangar demand analysis illustrated in **Table 3W** above supports the claim that the Airport is currently deficient in conventional, T-, and single-aircraft box hangars.

According to the discussion with airport management and existing tenants, conventional hangar space, or lack thereof, is a high priority need at SJT. In addition to the lack of available conventional hangars at the airport, several tenants noted that available hangars lack the proper door heights and widths to fit some of the larger turbine aircraft. The preferred size for conventional hangars at SJT range somewhere between 20,000 – 24,000 square feet in size. The hangar analysis suggests the Airport is approximately 29,000 square feet deficient in conventional hangar space today, with forecasted deficiencies ranging from 52,800 – 99,400 square feet throughout the remainder of the planning horizon. It should be noted that the existing AMCOM north and south hangars (No. 102 and No. 108) at 80,000 and 42,000 square feet respectively, could provide approximately 122,000 additional square feet of conventional hangar space if they were properly refurbished to meet current safety and environmental requirements. The Airport has explored this option in the past and found it to be very costly. In any case, the option to reuse these hangars exists should a private developer or company wish to make the investment. Conversely, it may be less of an investment to construct new conventional hangars with smaller footprints that may serve the needs of existing and future users alike. Both are feasible options for SJT to consider.

T-hangars and single-aircraft box hangars are also in demand at SJT. Although the existing and forecast baseline total square footage varies in Table 3T (hangar needs) for these hangars, the analysis still suggests that demand for these types of hangars exists. Furthermore, because these existing hangars are currently not large enough to accommodate any multi-engine piston aircraft, these aircraft types were not included in the forecast projections. Thus, not only does a need for additional T- and single-aircraft box hangars exist, the demand may be greater than what is reflected from the analysis. All hangars of this type are also at capacity at the Airport. The analysis suggests that an additional 2,800 – 11,200 square feet of T-hangars and/or single-aircraft box hangars are needed within the planning horizon. In order to reflect the demand to accommodate multi-engine piston aircraft, it is safe to assume double the forecasted amount may be necessary, resulting in approximately 5,600 – 22,400 square feet needed for T- and single-aircraft box at SJT through 2037.

Recommendations for the amount and location of additional hangars will be explored during the Alternatives Development analysis and recommendations ultimately displayed on the Airport Layout Plan (ALP). It is important to note that hangars of all types are not normally eligible for FAA Airport Improvement Plan (AIP) funding, and therefore are usually funded by the sponsor, private investor, or a combination thereof. Thus, it is also recommended that the City continue to monitor the actual demand for hangars at the Airport and make adjustments in the types and number of hangars as needed over the course of the planning horizon.

Aircraft Parking Aprons

As previously mentioned in Chapter One, three designated aircraft parking aprons are available at the Airport. The GA aircraft parking aprons include the North and South Aprons. However, the North Apron is currently utilized for storage of Envoy Air's regional jets, and therefore based and transient GA aircraft mostly utilize the South Apron for parking. Combined, these aprons encompass approximately 175,000 square yards of pavement, with the South Apron making up the majority of this area with approximately 135,000 square yards of pavement.

Applying the same methodology discussed above resulted in an estimation of the aircraft parking needs for based and transient aircraft at SJT within the planning horizon. The apron parking needs for based aircraft were calculated using the existing based aircraft storage assumptions found in **Table 3S.**

Apron parking needs for aircraft other than based were calculated using the forecasted GA design day and the percentage of GA itinerant operations within the design day over the 20-year period. Then, an average apron square-yardage requirement was applied to the total based and itinerant aircraft calculated (using ACRP Report 113 as a guide with modifications specific to SJT), which produced the total amount of aircraft parking apron needed for both. For based aircraft, an average of 1,100 square yards was used, which represents the footprint of some of the larger based aircraft found on the Airport's apron today. Likewise, for the itinerant aircraft, an average of 1,200 square yards was used, which represents the footprint of some of the mid-size corporate jets that use the Airport today (mostly in the Cessna family of jet aircraft), and that are anticipated to use the Airport in the future. Both the based and itinerant square-foot averages include the appropriate taxilane separation and set-back requirements.

Based on the existing and forecasted aircraft fleet mix at SJT over the 20-year planning period, the total existing aircraft apron areas should be more than adequate to accommodate based and itinerant aircraft parking and maneuvering needs. The South Apron should continue as the primary GA apron, but portions of the North Apron could also be utilized if needed (excluding the area where any commercial service jets may be temporarily parked) **Table 3X** illustrates the estimated based and transient aircraft parking apron needs over the 20-year planning horizon.

TABLE 3X
Existing and Forecasted GA Aircraft Parking Apron Needs

Apron Area (SY)	2017	2022	2027	2037
Total GA Apron Area[1]	161,800[2]	160,500[3]	160,500[3]	160,500[3]
Estimated Total Apron Area Required	**33,800**	**35,000**	**36,100**	**40,700**
+Surplus/-Deficit	+128,000	+125,500	+124,400	+119,800
Estimated Total Aircraft Parked on Apron[4]	**29**	**30**	**31**	**35**

Notes: *[1]Includes all apron pavement, such as taxilanes and other areas within the North and South Aprons. There is no formal delineation between based and transient apron at SJT, although it can be assumed that designated transient apron is allocated adjacent to both FBO facilities. [2]Total apron excludes the approximately 13,200 SY required for the five Envoy Air aircraft (CRJ 700) parked on the North Apron. [3]Total apron excludes the approximately 14,500 SY required for the five Envoy Air aircraft (CRJ 900) assumed to be parked on the North Apron throughout the remainder of the planning horizon. [4]Includes based aircraft and total transient aircraft simultaneously parked on apron during the busiest hour of the average day within the peak month.*

Source: *C&S Engineers, Inc. analysis 2019*

Fixed Base Operator (FBO)/Flight Schools

The SJT terminal building requirements described in the preceding section included those requirements related to the commercial service activity at the Airport. All other activity at the airport that is not related to commercial service operations is considered GA activity. Typically, GA airports may include an administration building where airport personnel are stationed, and that facility also serves as a terminal building for transient visitors or based tenants. In other instances, the FBO facility serves as the GA terminal. At SJT, Ranger Aviation and Skyline Aviation are FBOs whose facilities also serve as the GA terminal facilities.

Much like the commercial service terminal, FBO facilities are comprised of public common space, such as lobbies/waiting areas, restrooms, meeting rooms, snack bar/restaurants, or any other nonexclusive areas accessible to the public. Therefore, in order to determine if the existing GA terminal space is adequate to meet demand throughout the planning horizon, only the common space associated with these facilities was analyzed.

To determine the forecasted size requirement for a GA terminal building to meet current and future demand, the forecasted GA annual operations were used to derive the peak month, design day, and design hour operations. The forecasted design hour was then used to determine the peak-hour pilot and passenger throughput calculation; the peak-hour pilot and passenger calculation is determined by multiplying the design hour by the industry standard of 2.5. The peak-hour pilot and passenger calculation provide an estimate of the number of pilots and passengers an airport might expect to utilize the terminal (or FBO) building during the average busy day during the peak month of activity.

The product of the peak-hour pilot and passenger calculation is then multiplied by a square-footage – in this instance an industry standard of 100 square feet – to provide the estimated amount of area required to meet demand. **Table 3Y** summarizes the outcome of these calculations for SJT.

TABLE 3Y
Forecasted GA Terminal Building Needs at SJT

Year	Forecasted GA Annual Operations	Peak Month Operations	Design Day Operations	Design Hour Operations	Peak-Hour Pilot and Passengers	Common Space Required (SF)
2017	35,150	3,808	123	19	48	4,800
2022	36,782	3,985	129	20	50	5,000
2027	38,496	4,170	135	21	53	5,300
2037	42,191	4,571	148	23	58	5,800

Note: *Results rounded to the nearest whole number to simplify calculations.*
Source: *C&S Engineers, Inc. analysis 2019*

The combined area of the existing FBO facilities' common space totals approximately 2,025 square feet. This alone does not appear to meet the GA common space requirements as illustrated in **Table 3Y**; however, a designated GA administration area (with restroom) also exists within the terminal building that is approximately 3,117 square feet in size (see Exhibit 1F). Thus, the FBO common area combined with the City's GA administration area totals approximately 5,142 square feet. According to the outcome of the peak-hour pilot and passenger calculations, this space should adequately meet the needs for GA users through 2022, although may start to experience some constraint shortly thereafter and throughout the remainder of the 20-year planning horizon. Again, constraint will depend on actual demand for use of these GA facilities and how the existing facilities are utilized in the future. The City should continue to monitor the space based on feedback from the FBOs and airport personnel. Presently, there is no indication from either the FBOs or Airport management that the GA common space facilities are constrained at SJT. Routine maintenance and repair on the FBO buildings and City terminal GA space is necessary over the planning period.

At many GA airports, flight schools are often based within an FBO. At SJT, Skyline Aviation offers FAR Part 141 flight training as one of its services. Flight training at the airport has historically experienced ups and downs in line with economic cycles as noted in the Forecast chapter. There are currently 35 flight students at Skyline, and as of today there are no immediate plans to add additional trainer aircraft or pursue other expansion projects.

SASO and Other GA Tenants

The results of the SWOT analysis from the PAC and TAC meetings suggest that SJT is lacking in these areas:

- Availability of storage hangars, to include storage hangars of adequate size and function

- Lack of office space for existing hangars
- Centralized fuel farm facility
- Power lines along Hangar Road impede development to the west, and also currently hinder operations for a couple of existing tenants (notably FedEx and Poor Boy Avionics).

These concerns will be further examined and evaluated in the Alternatives Analysis, and eventually a preferred option for each may be reflected on the ALP.

GA Access & Parking Facilities

Access Road

From the main Airport entry road — Reary Boulevard, access to GA facilities in the north and south areas of the airfield are accessed via Hangar Road. Overall, Hangar Road appears to be in fair condition, with some portions of the road in worse condition than others. For example, the portion of pavement north of FAA Road and leading up to the hangar area at the north end, shows signs of heavy wear and cracking, as does the portion adjacent to the Poor Boy Avionics and First Flight hangars and near the last T-hangar facility at the far south end.

It is recommended that routine maintenance of this access road continue, and it is likely that all, or portions of, Hangar Road will need some form of pavement rehabilitation in the 20-year planning period.

Vehicle Parking

All GA facilities at SJT have vehicle parking available either directly adjacent to hangars/buildings, or in nearby parking lots. At this time, vehicle parking is not a concern for the existing GA tenants and users of the Airport, and it appears existing demand meets the current vehicle parking available. However, much like Hangar Road, some vehicle parking lots are in need of rehabilitation, in particular the lot associated with Hangar #108 just north of the terminal building. It is recommended that the Airport, or the GA lessee, invest in routine maintenance of the vehicle parking areas, and it is likely some form of rehabilitation of these parking areas will be needed within the 20-year planning period.

Support Facility Requirements

Airport Maintenance

As noted in Chapter One – *Inventory*, the Airport currently includes two airport maintenance and equipment facilities on the airfield. The approximate 1,900-square foot building adjacent to the ATCT and Terminal and the 3,400-square foot building in the southeast quadrant of the airfield meet the current and projected needs of airport personnel.

Air Traffic Control Tower

The FAA currently maintains and operates the ATCT located just north of the Terminal building. Although the structure itself is outdated, does not meet ADA requirements, and is beginning to show signs of wear, it remains functional. The ATCT stands 1982.6 feet above mean sea level (MSL) and meets line-of-sight requirements as outlined in FAA Order 6480.4A, *Airport Traffic Control Tower Siting Criteria*. While the ATCT is functional in its current location, relocation to support potential terminal modifications will be considered as a part of the Alternatives Analysis Chapter. The line-of-sight of the ATCT will be re-evaluated for any alternatives that involve changing runway ends.

One concern of both the PAC and TAC noted at the onset of the airport master planning process was the lack of 24-hour ATC services at SJT. Currently, the ATCT is operational from 7 a.m. until 9 p.m. daily; outside of these hours, pilots must utilize the common traffic advisory frequency (CTAF) and/or UNICOM radio frequencies to report their locations within the traffic pattern and on the movement areas of the airfield. The ATCT is a FAA contract tower that is managed and staffed independently. It is likely that current activity at the Airport does not warrant 24-hour ATC service; however, Airport management should continue to monitor and document any concerns about airspace or other functions related to its ATCT from its users, and respond appropriately as needed.

Airport Rescue & Fire Fighting (ARFF)

SJT currently falls within ARFF Index B based on the existing commercial service aircraft operating at the airport today (CRJ-700), and currently meets the equipment and fire extinguishing agent requirements for this Index as established in CFR Part 139.317 – *Aircraft rescue and firefighting: Equipment and agents*.

SJT is forecasted to accommodate a larger version of the CRJ beginning in the 2027 planning period – the CRJ-900. Based on the fuselage length of this aircraft, SJT will remain within ARFF Index B throughout the 20-year planning horizon. The airport should continue to maintain its current ARFF vehicle fleet and replace as necessary once a vehicle's useful life has ended. The primary firefighting vehicle – an Oshkosh Striker 4x4, was purchased new in 2017 and is in excellent condition.

The ARFF building is in overall good condition and meets the Airport's and ARFF personnel's needs. Routine building maintenance should be performed on an as needed basis. It's location on the airfield is considered adequate, and there are no plans to relocate the facility to a new location on the airfield within the planning period. Future changes to runway and taxiway alignments have potential to impact ARFF response times and the location will need to be considered as a part of the alternatives evaluation process.

Electrical Vault/Utilities

The airfield electrical vault is located just north of Hangar 108 and the North Apron (see Exhibit 1H – *Landside Facilities*) and is in good condition. The current size of the building and the equipment inside are adequate to meet the Airport's current airfield electrical demand. However, the Airport should continue to monitor and maintain the equipment and replace as needed.

The current capacity for all utilities discussed in the Inventory element is adequate for present day demands. However, some tenants have expressed concerns with the water/sewer system, low power lines (along Hangar Road), and some areas of poor drainage on the airfield. Future development may require enhanced or additional electrical or water capacity to meet the power needs of the operation or to meet fire codes (usually for new hangar developments). As such, during the planning phase of all future proposed development, coordination with the local utility providers should occur to ensure sufficient capacity exists. Furthermore, if the City of San Angelo desires to determine the adequacy of the existing infrastructure at SJT, it is recommended that a general utility study be performed to gauge the Airport's current systems, which in turn should assist in estimating the future utility demands needed to support the proposed future development contained in this Master Plan update.

FACILITY REQUIREMENTS SUMMARY

A summary of each of the areas discussed is included in **Table 3Z** below.

TABLE 3Z
Summary of Identified Requirements

Demand/Capacity	
Airfield Capacity	No Action Needed
Airside Facility Requirements	
Runway Length/Width	No Action Needed (based on carrier route structure)
Runway Designation	Re-designate Runway 3-21 as Runway 4-22
Runway Strength	Routine maintenance required
Runway Wind Coverage	No Action Needed
Runway Strength	Routine capital maintenance
Runway Thresholds	Relocate RWY 3 Threshold (see Runway Incursion Mitigation)
RSA and ROFA	No Action Needed
Runway Protection Zone	Mitigate incompatible uses within RPZ's on Runway 9 and Runway 18 end
Runway Incursion Mitigation	Runway 3 and Runway 36 threshold proximity requires geometry changes to deconflict
Taxiway Width	All new and reconstructed taxiways should be designed to TDG 2 standards, 35 feet wide
TSA and TOFA	Mitigate TOFA penetrations on Taxiway A
Run-up Areas	Proper marking and sizing
Problematic Taxiway Geometry	Reconfiguration of multiple areas
Taxiway Pavement Strength	Routine capital maintenance
Airfield Markings/Lighting	(See Runway Designation)

TABLE 3Z Summary of Identified Requirements	
Airfield Signage	Update taxiway nomenclature to comply with EB N. 89
Navigational Aids	No Action Needed
Weather Observation Equipment	No Action Needed
Terminal Area Requirements *	
Aircraft Parking Positions	No Action Needed
Passenger Check-in/Bag Drop	No Action Needed
EDS Baggage Screening	No Action Needed
Outbound Baggage	No Action Needed
Passenger Security Screening	No Action Needed
Holdrooms and Boarding Gates	Expansion needed if simultaneous 3-gate operation begins
Concessions	Existing is adequate, but there is room for improvement in post security offerings
Inbound Baggage Makeup and Baggage Claim	No Action Needed
Restrooms	No Action Needed
Circulation	No Action Needed
Office Space	No Action Needed
Landside Requirements	
Cargo Facilities	No Action Needed
Fuel Facilities	No Action Needed
Access and Parking	No Action Needed
Airfield Perimeter Fencing, Gates, and Security	Assess all gates/entry points to identify redundancies and inefficiencies
Security	No Action Needed
General Aviation Requirements	
Aircraft Hangars	Construct additional T-hangars and conventional hangars
Aircraft Parking Aprons	Routine capital maintenance
FBO and Flight Schools	No Action Needed
Access Roads	No Action Needed
Vehicle Parking	No Action Needed
Support Facility Requirements	
Airport Maintenance	No Action Needed
Air Traffic Control Tower	No Action Needed
Airport Rescue & Fire Fighting	No Action Needed
Electrical Vault/Utilities	Future development may require updating utility infrastructure capacity

** Terminal requirements based on baseline forecast. If additional service is introduced on a similar schedule, improvements will be needed. This issue to be examined in the development of alternatives.*