Chapter Four

Airport Facility Requirements

4.1 Introduction & Planning Activity Levels (PALs)

This chapter presents the future requirements for airport facilities to inform the City of the infrastructure required to meet the projected demand throughout the planning period at Springfield-Branson National Airport (SGF or Airport). In addition to providing sufficient capacity, consideration has been given to providing acceptable levels of service to all airport users throughout this section.

The requirements presented herein are primarily based on the demand and traffic projections presented in Chapter Three – *Forecast of Aviation Demand* of this Master Plan report. The requirements were calculated using Federal Aviation Administration (FAA) standards and established industry planning standards, where applicable. For master planning, the requirements presented in this chapter are tied to the demand for various Planning Activity Levels (PALs). These PALs, while associated with a projected point in time-based on the Forecast of Aviation Demand (5, 10, 15, and 20 years in the future), allow the Airport flexibility in the implementation of future projects based on actual growth in demand. **Table 4.1-1** presents the four PALs, their respective traffic volumes, and the projected point in time in which they are to occur.

Table 4.1-1: Planning Activity Levels

PAL	PROJECTED YEAR	TOTAL BASED AIRCRAFT	TOTAL ANNUAL OPERATIONS
Existing	2021	143	57,336
PAL 1	2026	154	64,532
PAL 2	2031	164	71,726
PAL 3	2036	174	77,160
PAL 4	2041	186	82,262

Source: CMT, FAA TAF (2021)

4.2 Airfield & Airside Requirements

The determination of airside facility requirements falls into four broad categories:

- Runway Wind Coverage – Assess the predominate wind conditions over a period of at least ten years which is then used to determine the adequacy of the existing runway alignments at SGF.
- Runway Length – Calculates the runway length needed to accommodate the existing and projected fleet mix.
- Runway Design Standards – Compares the current runway geometry to modern runway design standards to identify where changes and updates may be necessary, this includes not only physical runway pavements but runway safety areas and protection zones as well.
- Taxiway Design Standards – Compares the current taxiway geometry to modern taxiway design standards to identify where changes and updates may be necessary.

4.2.1 Airport Reference Code & Critical Aircraft

The Airport Reference Code (ARC) is an airport designation that is used to help categorize the airport's existing airfield capability, as determined by a set of design standards prescribed by the FAA. The ARC consists of two components; the first is a letter (A through E) that indicates the Aircraft Approach Category (AAC), and the second is a Roman numeral that indicates the Airplane Design Group (ADG). **Table 4.2-1** presents the various levels of ARC as defined by FAA Advisory Circular (AC) 150/5300-13B, *Airport Design*.

Table 4.2-1: Airport Reference Code

AIRCRAFT APPROACH CATEGORY		AIRPLANE DESIGN GROUP		
AAC	APPROACH SPEED (KNOTS)	ADG	TAIL HEIGHT (FT.)	WINGSPAN (FT.)
A	< 91	I	< 20	< 49
B	91 ≤ and < 121	II	20 ≤ and < 30	49 ≤ and < 79
C	121 ≤ and < 141	III	30 ≤ and < 45	79 ≤ and < 118
D	141 ≤ and < 166	IV	45 ≤ and < 60	118 ≤ and < 171
E	166 ≤	V	60 ≤ and < 66	171 ≤ and < 214
		VI	66 ≤ and < 80	214 ≤ and < 262

Source: FAA AC 150/5300-13B

As identified in the Forecast of Aviation Demand chapter, the existing ARC at SGF is **D-IV**. The ARC is determined by the critical aircraft which, in SGF's circumstance, is a combination of the commercial aircraft fleet mix consisting of Boeing's B737-800, B737-900, B757-300, and general aviation aircraft with Gulfstream's GLF4, GLF5, and GLF6. The existing Airplane Design Group (ADG) at SGF is considered an **ADG IV** largely due to the cargo operations with the B757-200 aircraft. Based on the fleet mix analysis completed in the Forecast of Aviation Demand chapter, SGF's future fleet mix will be comprised of the following airframes:

- Large Jet/Multi-Engine

- Commercial
- Aircraft with a maximum takeoff weight (MTOW) greater than 300,000 pounds

As stated in Chapter Three – *Forecast of Aviation Demand*, the future critical aircraft, and ARC are recommended to remain D-IV. However, the B767-300F is projected to replace the B757-200 in the air cargo fleet. The future fleet mix is expected to still span from piston-driven aircraft to commercial/cargo aircraft.

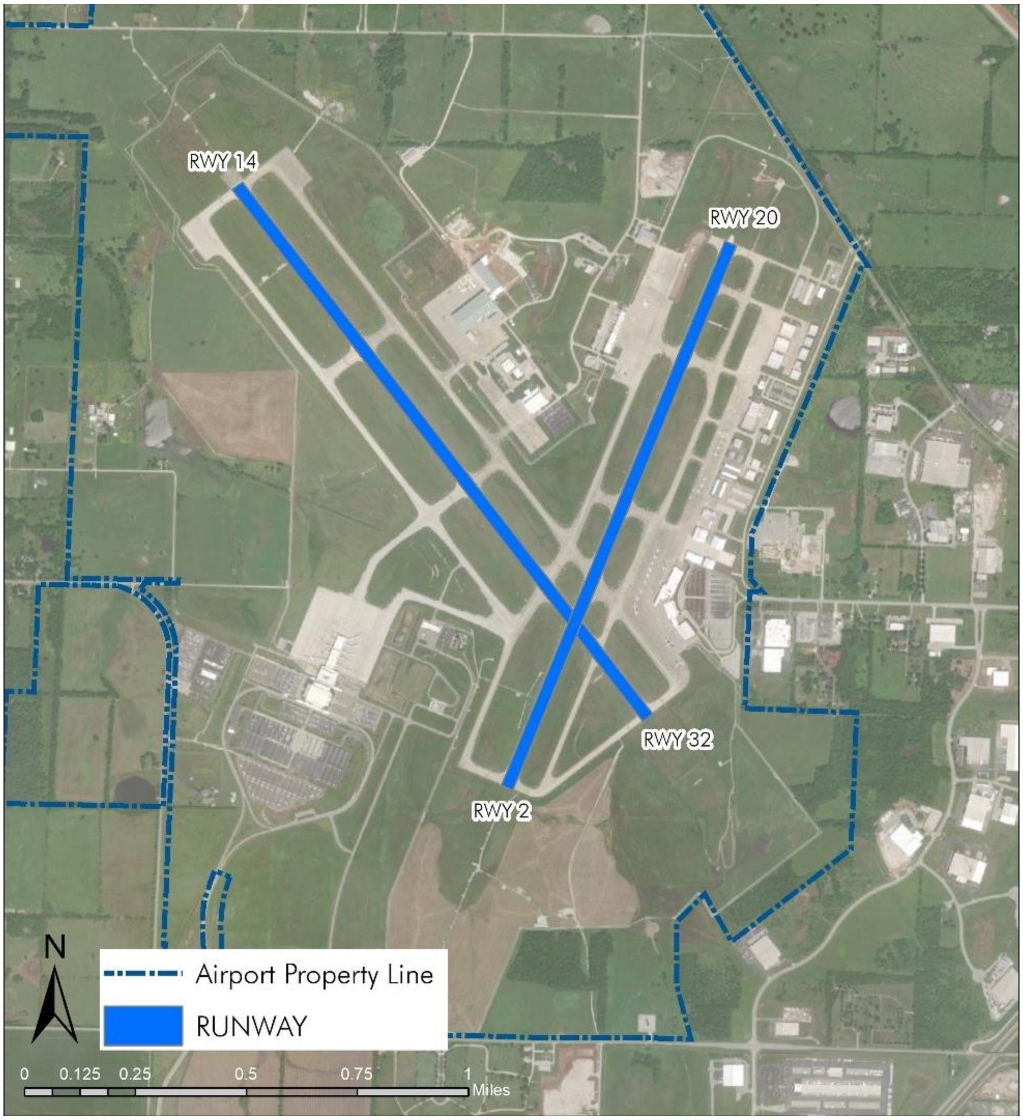
4.2.2 Airfield Capacity Analysis

The purpose of the SGF Airfield Capacity Analysis is to determine the capacity of the airfield in terms of the maximum number of operations that can be accommodated. This capacity is then compared to projected demand through PAL 4 to identify if and when additional airfield capacity may be needed.

The Airport's runway system is the central component in the assessment of airfield operational capacity. Airports that utilize a single runway or intersecting runway systems to accommodate their demand generally have lower operational capacity than airports that have parallel runways.

The existing runway configuration presented in **Exhibit 4.2-1** is comprised of two intersecting paved runways designated as Runway 14-32 (Primary) and Runway 02-20.

Exhibit 4.2-1: SGF Existing Airfield Configuration



Source: CMT (2022)

METHODOLOGY

The "Handbook Method," or the methodology prescribed in FAA AC 150/5060-5 - *Airport Capacity and Delay*, was used to determine the capacity of the existing airfield system at SGF. This methodology relies upon the projected fleet mix of aircraft and the number of operations projected by each aircraft classification in the fleet mix. Table 4.2-2 presents the aircraft classifications as defined by the FAA for the determination of airfield capacity and aligns these classifications with the projected fleet mix type from the Forecast of Aviation Demand chapter of this Master Plan.

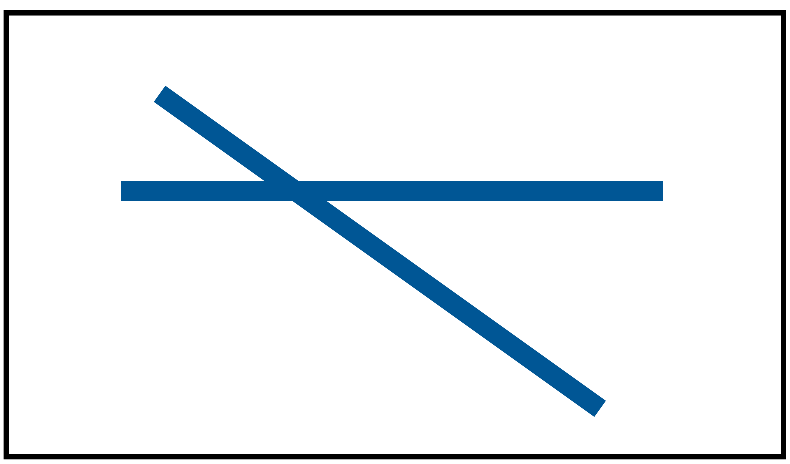
Table 4.2-2: Aircraft Classifications

FLEET MIX TYPE	AC 150/5060-5 AIRCRAFT CLASSIFICATIONS			
	CLASS	MTOW (LBS.)	ENGINES	WAKE TURBULENCE CLASSIFICATION
Piston	A	< 12,500	Single	Small
Turbo Prop	B		Multi	
Light Jet	B			
Small Jet	B			
Medium Jet	B			
Large Jet	C	12,500 – 300,000		Large
Commercial	C			
N/A	D	> 300,000		Heavy

Source: FAA AC 150/5060-5, CMT (2022)

In addition to the projected fleet mix, the "Handbook Method" relies on a set of standard airfield configurations. There are 19 total configurations identified by AC 150/5060-5. These 19 configurations can account for most airfield configurations that exist. The intent of the AC is for the user to apply the standard configuration that most closely represents the airfield being assessed. Runway-use configuration N°9 was selected as the appropriate configuration to use, as shown in **Exhibit 4.2-2. Table 4.2-3** presents the corresponding capabilities of runway-use configuration N°9 in terms of hourly capacity under both visual flight rules (VFR) and instrument flight rules (IFR) as well as annual service volume (ASV).

Exhibit 4.2-2: Runway-use Configuration N°9



Source: FAA AC 150/5060-5

Table 4.2-3: Configuration N°9 Capacity

MIX INDEX (%C+3D)	HOURLY CAPACITY		ANNUAL SERVICE VOLUME (ASV)
	VFR	IFR	
0 to 20	98	59	230,000
21 to 50	77	57	200,000
51 to 80	77	56	215,000
81 to 120	76	59	225,000
121 to 180	72	60	265,000

Source: FAA AC 150/5060-5

AIRFIELD CAPACITY RESULTS

Mix Index Calculation

The Mix Index is determined by the percentage of operations conducted or projected by each of the four classes of aircraft (A, B, C, and D) as defined in **Table 4.2-2**. The percentages of each class of operations are then applied to the formula Mix Index = %C+(3*%D). For this analysis, all Light Jets and Commercial Air Carrier operations are assumed to be Class C aircraft. **Table 4.2-4** presents the projected number of annual operations by each fleet mix type. These projections were utilized to determine the Mix Index.

Table 4.2-4: Annual Operations by Fleet Mix Type

	AIRCRAFT CLASSES				MIX INDEX
	A	B	C	D	%(C+3D)
EXISTING	44%	21%	35%	0%	35%
PAL 1	39%	26%	34%	0%	34%
PAL 2	36%	28%	35%	1%	39%
PAL 3	34%	31%	34%	1%	38%
PAL 4	33%	34%	32%	1%	36%

Source: CMT (2022)

Table 4.2-5 presents the Mix Index for each PAL and the resulting airfield capacities. The results of this analysis indicate that the existing airfield configuration provides sufficient annual and hourly capacity in both VFR under visual meteorological conditions (VMC) and IFR under instrument meteorological conditions (IMC) throughout the planning period.

Table 4.2-5: SGF Airfield Capacity

	EXISTING	PAL 1	PAL 2	PAL 3	PAL 4
Mix Index (%C+3D)	21-50				
Runway Use Configuration	9				
VFR Hourly Capacity	77				
IFR Hourly Capacity	57				
Peak Hour Operations - Projected	15	17	19	21	22
Annual Service Volume	200,000				

Source: FAA AC 150/5060-5; CMT (2022)

Based on the calculations for each PAL and the airfield capacity shown in the table above, the results of this analysis indicate that the existing two-runway airfield configuration at SGF provides sufficient annual and hourly capacity in both VFR under IFR throughout the planning period.

Previous planning studies for SGF have included a provision for a third runway that would be parallel to existing Runway 2/20. In addition, this future runway has been factored into and is factored into local zoning through the established airport overlay (AO) districts. Although an additional runway does not appear to be justified in the current 20-year planning horizon, preserving land for the third parallel runway should remain a priority for SGF to ensure it has the capacity to meet operational demand in the future. An assessment of the future Runway 2L/20R planning corridor is provided in **Appendix 6**.

4.2.3 Runway Wind Coverage

The wind is a key factor influencing runway orientation and the required number of runways at an airport. Ideally, a runway should be aligned with the prevailing wind. Wind conditions affect all aircraft to varying degrees, but generally the smaller the aircraft, the more it is affected by wind, particularly crosswind components. Per FAA AC 150/5300-13B, *Airport Design*, the crosswind component should not exceed the velocities for the specific Runway Design Code (RDC) presented in **Table 4.2-6**, more than five percent of the time. The RDC for SGF is D-IV.

Table 4.2-6: Allowable Crosswind Component per Runway Design Code (RDC)

RUNWAY DESIGN CODE (RDC)	ALLOWABLE CROSSWIND COMPONENT
A-I and B-I	10.5 knots
A-II and B-II	13.0 knots
A-III and B-III C-I through C-III D-I through D-III	16.0 knots
A-IV and B-IV C-IV through C-VI D-IV through D-VI	20.0 knots
E-I through E-VI	20.0 knots

Source: FAA AC 150/5300-13B

METHODOLOGY

The analysis performed to evaluate the wind coverage of the existing airfield geometry at SGF for this Master Plan was consistent with the guidelines prescribed in FAA AC 150/5300-13B - *Airport Design*, Appendix B. When a runway or system of runways provides less than 95% coverage for the aircraft that are projected to use the runway(s) regularly, evaluating the need for a crosswind runway may be necessary.

Wind Coverage at SGF

A windrose provides a graphical presentation of the average wind direction and velocity observed at an airport over a period of time compared to the existing runway headings.

All-weather and instrument flight rules (IFR) windroses were created for SGF per FAA AC 150/5300-13B - *Appendix B Wind Analysis*, and are depicted in **Exhibits 4.2-3 and 4.2-4**, respectively. Hourly weather data required to create the windrose was obtained from the National Weather Service Forecast Office, Springfield, MO, for the period January 1, 2011, through December 31, 2020, and included wind direction and wind speed.

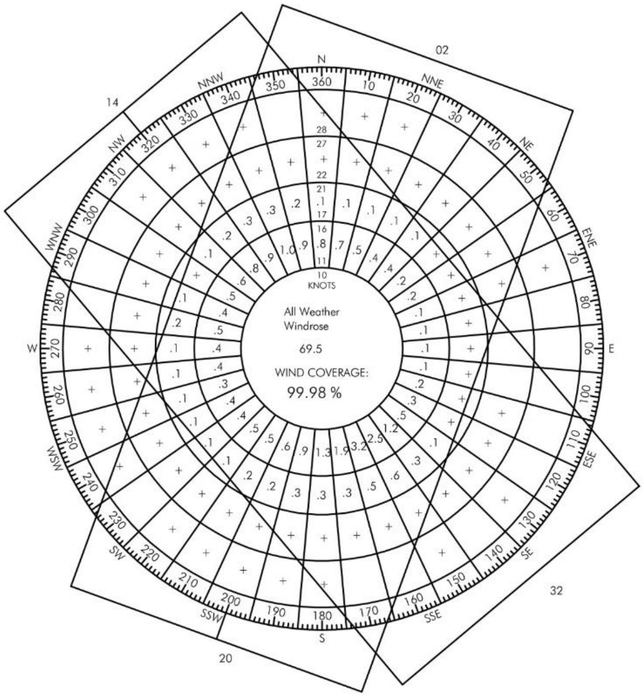
The wind direction, which is measured at ten-degree intervals between 0 and 360 degrees, is displayed by radial lines, with the directions labeled along the outer ring. The wind velocity is shown within the concentric circles at zero to ten knots, 11 to 16 knots, 17 to 21 knots, 22 to 27 knots, and 28 knots or greater.

Each segment of the windrose represents the percent occurrence of wind observations at the given direction and velocity range. Note that the center circle of the windrose displays the percent occurrence of wind observations at zero to ten knots regardless of wind direction. Percentages were calculated and rounded to the nearest one-tenth of one percent and entered in the appropriate segment of the windrose. Plus (+) symbols are used to indicate direction and velocity combinations that occur less than one-tenth of one percent of the time, but greater than zero percent of the time.

A crosswind template is overlaid on each windrose as parallel lines that show the existing runway end directions and crosswind limits, which for this analysis is 20 knots. This crosswind template is used to calculate the percent coverage offered by the runway orientation at each crosswind limit. By adding together the sum of the percentages that fall within each crosswind limit for all runways, the percent coverage can be calculated. The desirable wind coverage for an airport is 95%. This 95% considers various factors influencing operations and the economics of providing the coverage.

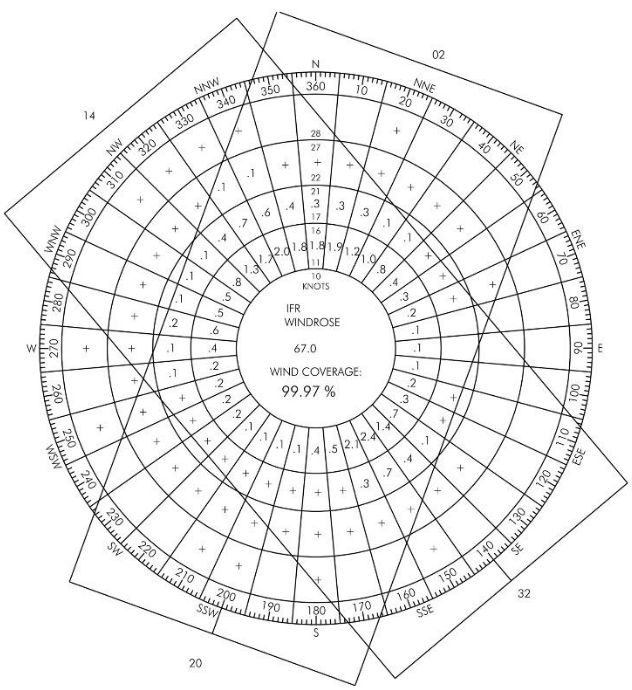
Based on the weather observations presented in the windroses for all-weather, the Airport provides at least 95% coverage under the existing runway configuration. **Table 4.2-7** and **Table 4.2-8** show the percentage of wind that is covered for each crosswind limit in all-weather and IFR conditions.

Exhibit 4.2-3: SGF All-Weather Windrose



Source: https://adip.faa.gov/KSGF , CMT 2022

Exhibit 4.2-4: SGF IFR Windrose



Source: https://adip.faa.gov/KSGF , CMT 2022

Table 4.2-7: All-Weather Wind Coverage by Runway End

CROSSWIND SPEED (KNOTS)	ALL-WEATHER WIND COVERAGE						
	14	32	14-32	2	20	02-20	All Runways
20	61.70%	44.91%	99.69%	42.47%	64.19%	99.76%	**99.98%**
16	61.10%	44.43%	98.61%	42.01%	63.40%	98.52%	**99.87%**
13	59.54%	42.86%	95.50%	40.46%	61.00%	94.57%	**99.47%**
10.5	57.58%	40.76%	91.45%	38.50%	57.19%	88.82%	**98.37%**

Source: *https://adip.faa.gov/KSGF*, CMT (2022)

Table 4.2-8: IFR Wind Coverage by Runway End

CROSSWIND SPEED (KNOTS)	IFR WEATHER WIND COVERAGE						
	14	32	14-32	2	20	02-20	All Runways
20	44.26%	61.82%	99.73%	62.14%	43.87%	99.66%	**99.97%**
16	44.08%	61.21%	98.95%	61.39%	43.01%	98.04%	**99.86%**
13	43.49%	58.89%	96.05%	59.05%	40.40%	93.11%	**99.51%**
10.5	42.84%	55.40%	91.92%	55.88%	36.82%	86.38%	**98.53%**

Source: *https://adip.faa.gov/KSGF*, CMT (2022)

The following runway wind coverage determinations can be made based on the results presented in the two tables above:

- Runway 14-32 and Runway 02-20 provide enough coverage for D-IV aircraft more than 95% of the time during all weather conditions.
- Runway 14-32 and Runway 02-20 provide enough coverage for D-IV aircraft more than 95% of the time during IFR weather conditions.

Based on this analysis, **the existing runway system at SGF provides enough wind coverage more than 95% of the time in all-weather and IFR weather conditions. For this reason, no further evaluation for a crosswind runway is needed at this time.**

A supplemental assessment was completed to investigate wind coverage patterns on individual runway ends while accounting for seasonal variations. Based on this assessment, it is observed that there is no distinct preference for a specific runway at SGF concerning favored wind direction and that annual operations for the critical design aircraft family exceed 500 on both Runway 14-32 and 02-20. This supplemental assessment is provided in **Appendix 7**.

4.2.4 Runway Design Standards

Ideally, all runways are designed and constructed following FAA guidelines and requirements at the time of construction. These guidelines will stipulate basic geometric requirements that enable a runway or runway system to accommodate traffic by a certain type or size of aircraft and will assist in identifying any airfield constraints that require modification. The following subsections present the runway compliance at SGF based on FAA AC 150/5300-13B, *Airport Design*.

As was mentioned in Section 4.2.1 of this chapter, the future ARC of SGF is **D-IV** based on future critical aircraft determination. Therefore, this chapter assesses the airfield's infrastructure against the FAA's requirements for an RDC of D-IV for both runways.

CRITICAL AIRCRAFT

The specific set of guidelines to which an airfield is to comply is determined by the size and needs of the largest aircraft which operates at an airport, or the "critical aircraft." FAA AC 150/5000-17, *Critical Aircraft and Regular Use Determination*, defines a critical aircraft as **the most demanding aircraft type, or grouping of aircraft with similar characteristics, that make regular use of an airport. Regular use of the Airport is defined as 500 annual operations, including both itinerant and local operations, but excludes touch-and-go operations.** One landing is considered an operation as is one takeoff.

The FAA uses a coding system to relate airport design criteria to the operational and physical characteristics of the critical aircraft at an airport and classifies the critical aircraft using the following parameters: Aircraft Approach Category (AAC) – classified according to aircraft approach speeds and Airplane Design Group (ADG) – defined by its wingspan and tail height, whichever is most restrictive.

Chapter Three of this Master Plan identified the B737-800/900 family of aircraft as the most demanding aircraft used by commercial operators, and the B757-200 as the most demanding aircraft used by Cargo operators at SGF. However, the B767-300F is anticipated to replace the B757-200 in the air cargo fleet. Combining the operations of the most demanding aircraft indicates that the future critical aircraft for the airfield is a combination of the B737-900/900, as well as the B767-300F. According to interviews with the Air Traffic Control Tower, the utilization of these aircraft is similarly distributed over both runways. Anticipating the continued use of these aircraft as well as upgauging, D-IV will continue to be the ARC used to determine airfield design. **Table 4.2-9** presents the critical aircraft currently listed for each runway as well as that aircraft's respective design grouping information.

Table 4.2-9: Critical Aircraft Information

FAA PARAMETER	RUNWAY 14-32	RUNWAY 02-20
Critical Aircraft	B767-300F	
AAC	D	
ADG	IV	
ARC	D-IV	
TDG	5	

Source: CMT (2022)

RUNWAY GEOMETRY

Table 4.2-10 presents a comparison of each runway at SGF to the respective runway geometry design standards as prescribed by the FAA based on the future critical aircraft for each runway.

Table 4.2-10: Runway Geometry Standards Evaluation

DESIGN ELEMENT	RUNWAY 14-32				RUNWAY 02-20			
	EXISTING		FUTURE		EXISTING		FUTURE	
	14	32	14	32	2	20	2	20
Runway Design Code	D-IV		D-IV		D-IV		D-IV	
Runway Width (ft.)	150		150		150		150	
Shoulder Width (ft.)	0		25		0		25	
Blast Pad Width (ft.)	200	0	200		0	200	200	
Blast Pad Length (ft.)	200	0	200		0	200	200	

Source: FAA AC 150/5300-13B

The runway geometry at SGF mostly aligns with FAA standards; however, SGF lacks the 25' paved shoulders on both runways and does not have blast pads on the ends of runways 32 and 2.

Constructing 200' by 200' blast pads at the aforementioned runway ends and adding 25' shoulders to the runways is recommended.

RUNWAY SAFETY AREAS & RUNWAY OBJECT FREE AREAS

FAA AC 150/5300-13B prescribes the geometric standards for Runway Safety Areas (RSAs) and Runway Object Free Areas (ROFAs) at airports in the United States. Each of these design elements are defined as follows:

RSA – A defined area surrounding the runway consisting of a prepared surface suitable for reducing the risk of damage to aircraft in the event of an undershoot, overshoot, or excursion from the runway.

ROFA – A clear area symmetrical about the runway centerline provided to enhance the safety of aircraft operations by remaining clear of objects, except for those necessary for air and ground navigation. The ROFA also provides wingtip protection in the event of an aircraft excursion from the runway.

The dimensions of these design elements are determined by the capabilities of the runway and the type of traffic the runway is intended to serve. **Table 4.2-11** presents a comparison of each runway at SGF and its associated RSA and ROFA to the respective dimensional guidance as prescribed by the FAA.

Table 4.2-11: RSA & ROFA Existing and Future Dimensions

DESIGN ELEMENT	EXISTING/FUTURE DIMENSION (FEET)	
	Existing	Future
RUNWAY 14-32 (RDC: D-IV)		
RUNWAY SAFETY AREA (RSA)		
Length Beyond Departure End	1,000	1,000
Length Prior to Threshold	600	600
Width	500	500
RUNWAY OBJECT FREE AREA (ROFA)		
Length Beyond Runway End	1,000	1,000
Length Prior to Threshold	600	600
Width	800	800
RUNWAY 02-20 (RDC: D-IV)		
RUNWAY SAFETY AREA (RSA)		
Length Beyond Departure End	1,000	1,000
Length Prior to Threshold	600	600
Width	500	500
RUNWAY OBJECT FREE AREA (ROFA)		
Length Beyond Runway End	1,000	1,000
Length Prior to Threshold	600	600
Width	800	800

Source: FAA AC 150/5300-13B

Exhibits 4.2-5 and **4.2-6** show the RSA and ROFA for Runways 14-32 and 02-20, respectively.

It is important to understand one of the purposes of protecting the land inside the RSA and ROFA is to provide an area for evacuation in case of an emergency. For this reason, it is the Airport's responsibility to ensure these areas remain free of objects or incompatibilities. As shown in the exhibits below, there are several instances of incompatible object(s) within each of these safety areas.

Mitigation of these objects may be achievable through one or a combination of operational restrictions, frangible mounting, or removal. In the instances where removal may be necessary, the Airport should evaluate the feasibility of doing so during the next upgrade or modification to the respective runway.

Navigational aids (NAVAIDs) typically should not be located within the RSA or ROFA, unless they are required to be in a specific location to function properly or are "fixed-by-function".[1]

"Fixed-by-function" NAVAID equipment can be defined as an object that is critical for its proper functioning and the safety benefit derived from the operation of the NAVAID outweighs the potential risk of an aircraft striking the NAVAID. A fixed-by-function determination allows NAVAIDs to be in the RSAs or OFAs[2].

Based on the analysis and exhibits shown below, it is determined there are several incompatible objects within the ROFA that are not considered "Fixed-by-Function".

- On runways 14-32 there is a wind cone (304.93' left of the centerline of RWY 14) within the ROFA, a localizer (On the centerline of RWY 32) within the RSA, and a portion of distance-measuring equipment (355.39' Right of the centerline of RWY 32) within the ROFA.

- On runways 02-20 there are two wind cones (280.78' left of the centerline of RWY 20) (281.76' right of the centerline of RWY 2) and a portion of distance-measuring equipment (271.17' left of the centerline of RWY 20) within the ROFA.

Supplemental wind cones are allowed within the ROFA provided they are currently frangible mounted. SGF's supplemental wind cones are frangible mounted. At such times when the wind cones need to be replaced, the FAA recommends that they be relocated outside of the ROFA, if physically possible within the supplemental wind cone siting criteria and if allowed by airfield geometry and topography.

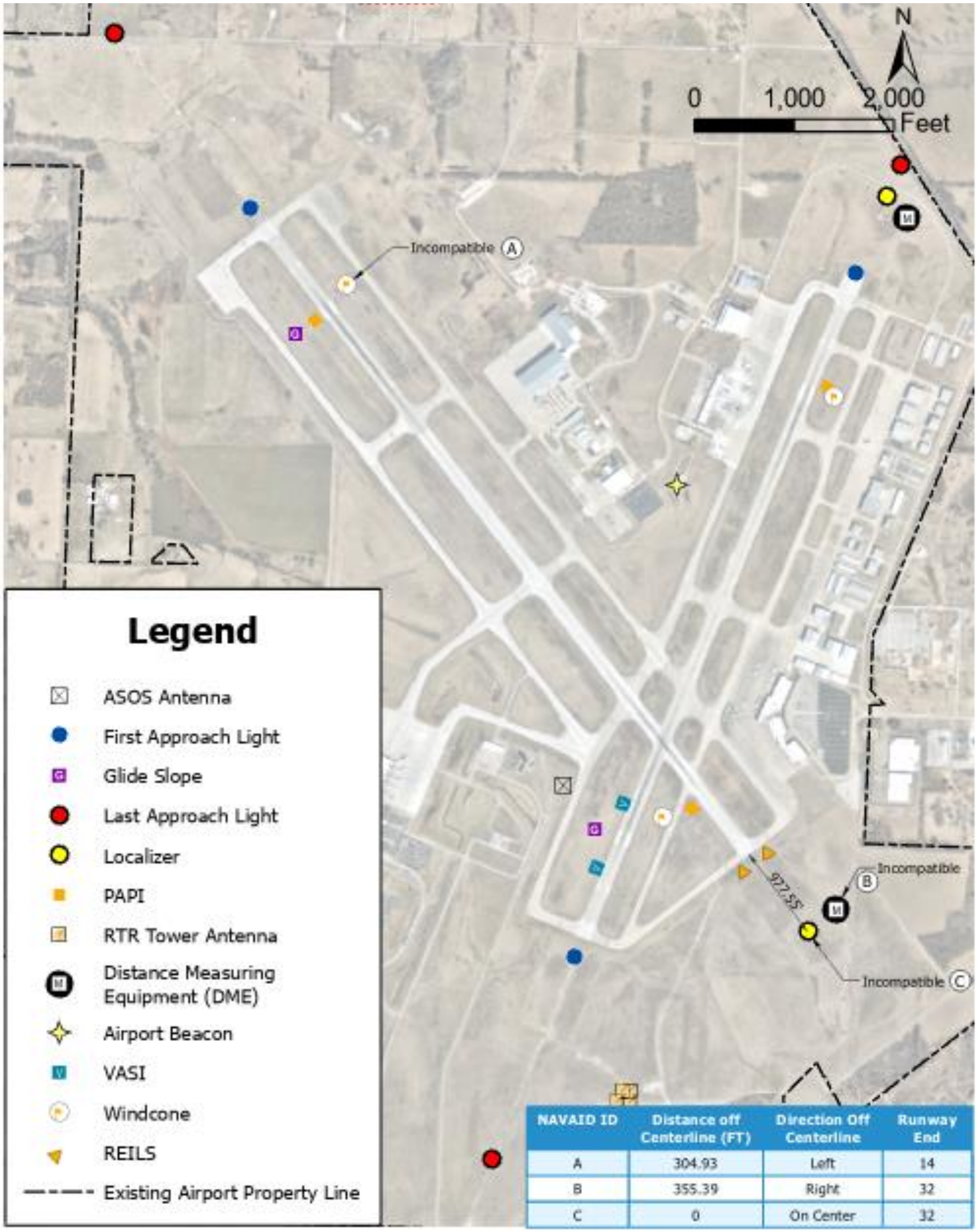
The DME antennas are located within the localizer equipment shelters within the ROFA. It is recommended that the shelters are located 1,000' beyond the end of the runway and outside the ROFA.

The localizer antenna located off the end of Runway 32 within the RSA, is measured 977.55' beyond the end of the runway. Just as with the DME equipment, it is recommended that the equipment is located 1,000' beyond the runway threshold, outside of the RSA.

Further, terrain off the end of Runway 32 within the ROFA penetrates the FAA's 20:1 visual approach surface. One result of this penetration is the less-than-optimal one-mile visibility minimums for the Runway 32 instrument approach procedure. The high area of terrain is likely associated with an embankment above an FAA Technical Operations service line in the vicinity. Lowering the service line and grading the area is necessary to mitigate the visual approach surface penetration and request lower (3/4 mile) instrument approach visibility minimums.

[1] FAA AC 150/5300-13B, *Airport Design*, Table 6-1
[2] FAA AC 150/5300-13B, *Airport Design*, Paragraph 6.11.6.1.

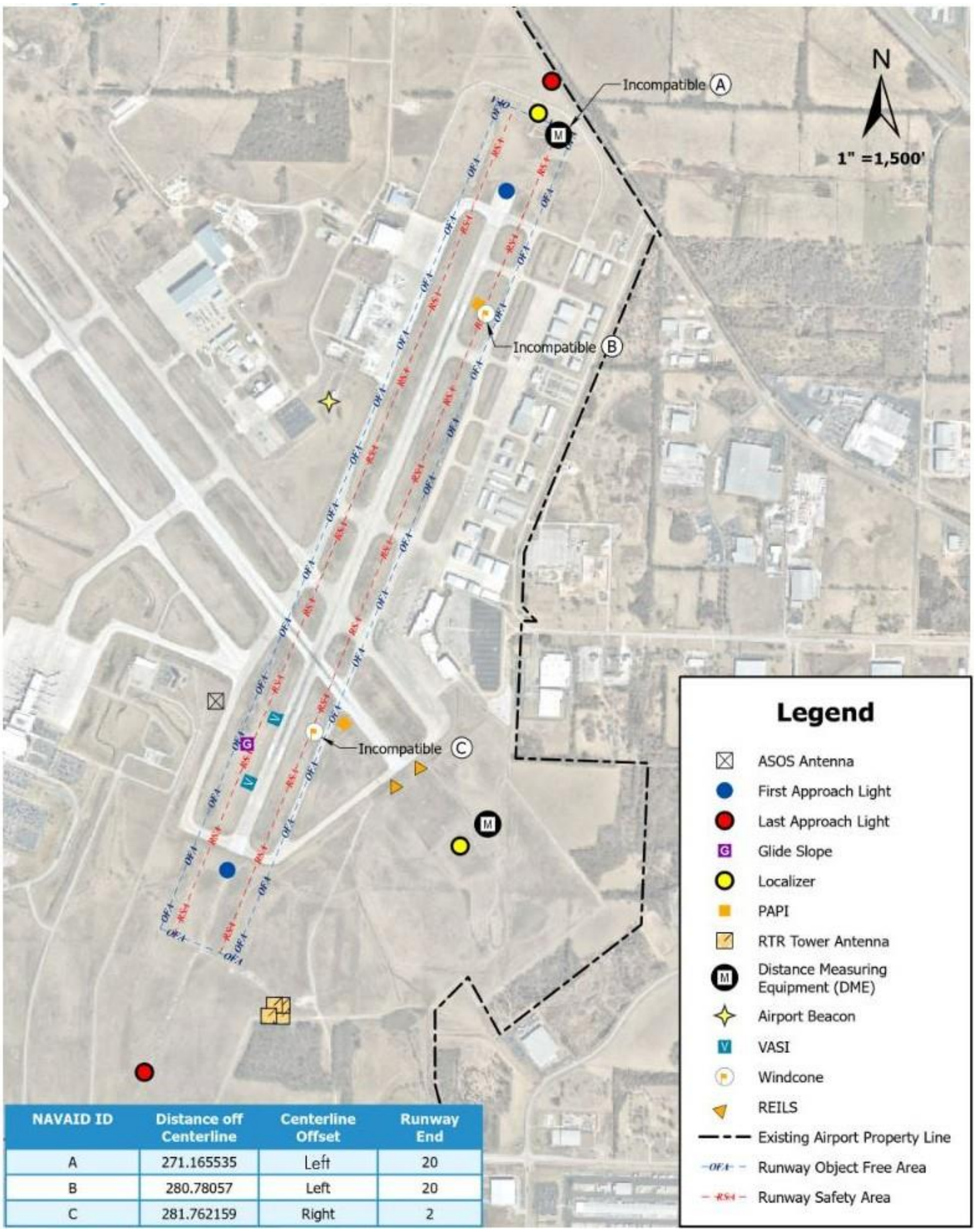
Exhibit 4.2-5: Runway 14-32 RSA & ROFA



NAVAID ID	Distance off Centerline (FT)	Direction Off Centerline	Runway End
A	304.93	Left	14
B	355.39	Right	32
C	0	On Center	32

Source: CMT (2022)

Exhibit 4.2-6: Runway 02-20 RSA & ROFA



NAVAID ID	Distance off Centerline	Centerline Offset	Runway End
A	271.165535	Left	20
B	280.78057	Left	20
C	281.762159	Right	2

Source: CMT (2022)

INSTRUMENT APPROACHES

An assessment of existing instrument approach procedures suggests that it is feasible to reduce visibility minimums on two runway ends, specifically:

- Minimums on the Runway 14 ILS approach can be reduced from ¾ mile to ½ mile with obstacle removal (on-airport trees).
- Minimums on the Runway 32 RNAV (GPS) approach can be reduced from 1 mile to ¾ mile with obstacle removal (on-airport terrain).

Further details about the feasibility of reducing the visibility minimums described above are provided in Appendix 8.

RUNWAY PROTECTION ZONES

The Runway Protection Zone's (RPZ) function is to enhance the protection of property and people on the ground. The RPZ is defined by the FAA as, "an area at ground level prior to the threshold or beyond the runway end to enhance the safety and protection of people and property on the ground." This is best achieved through airport owner control over the RPZs. Control is preferably exercised through the acquisition of sufficient property interest in the RPZ and includes clearing the RPZ areas (and maintaining them clear) of incompatible objects and activities. Typical mechanisms to achieve control are 1] ownership of the RPZ property in fee simple or 2] possessing sufficient interest through easements, deed restrictions, or municipal zoning to control land uses.

Per FAA AC 150/5190-4B, *Airport Land Use Compatibility Planning,* airport service roads not open to the public and directly controlled by the airport operator are considered a permissible land use in the RPZ and require no further evaluation.

Like RSAs and ROFAs, the dimensions of RPZs are determined by the RDC and visibility minimums. Anticipated reductions in visibility minimums on Runways 14 and 32 will result in larger RPZ dimensions. Table 4.2-12 presents the dimensions of each RPZ at SGF based on each runway's existing and future RDC and visibility minimums. Exhibits 4.2-7 through 4.2-10 illustrate each approach and departure RPZ for every runway end at SGF. Further explanation of the methodology used to determine the appropriate RPZ dimensions for the Runway 20 end is provided in Appendix 9.

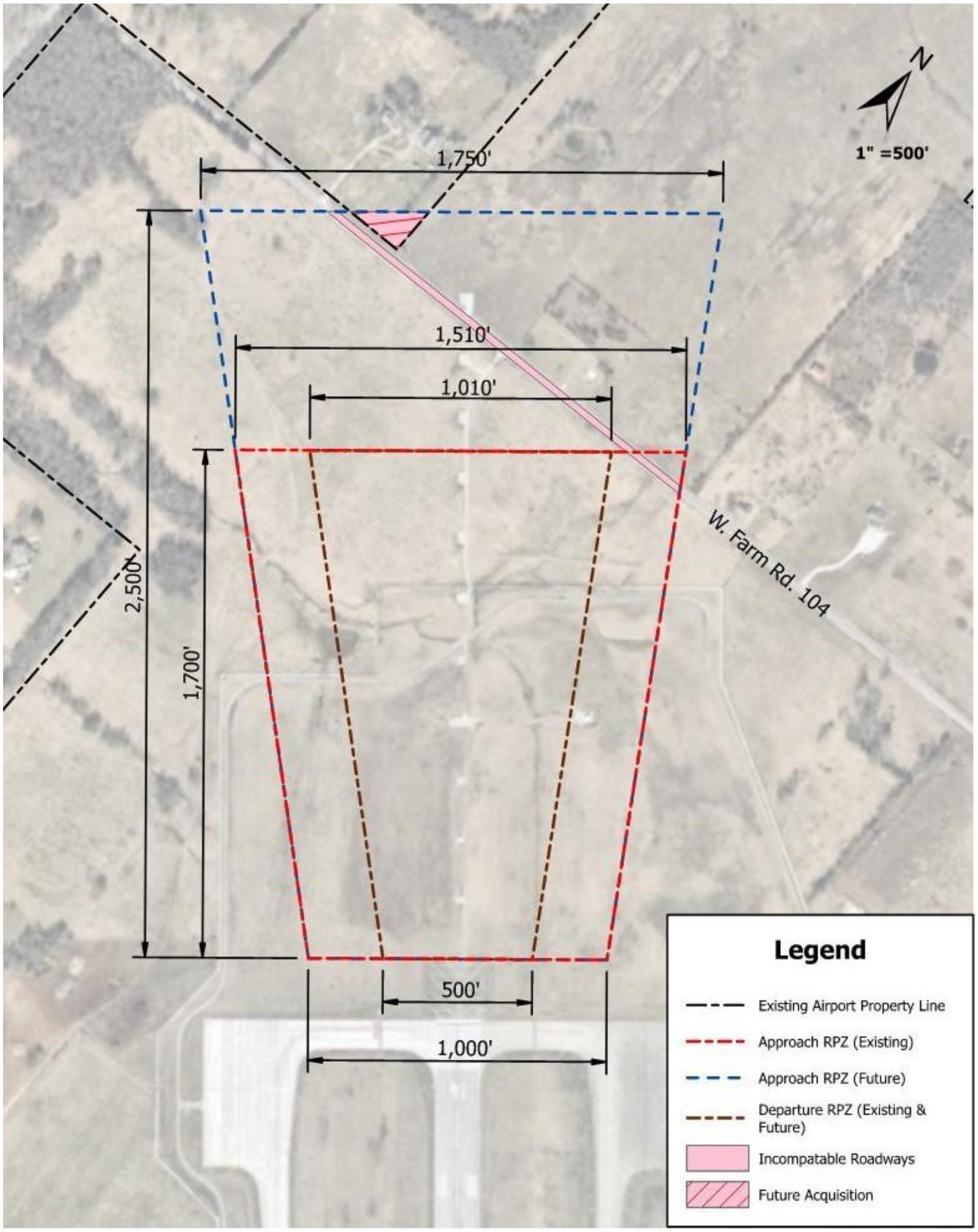
Similarly, with RSAs and ROFAs, the objective of SGF is to maintain each RPZ clear of any incompatible objects. For this reason, each RPZ exhibit is accompanied by an assessment of any incompatibilities.

Table 4.2-12: RPZs Exiting and Future Dimensions

PROTECTION ZONE	EXISTING DIMENSION (FEET)		FUTURE DIMENSION (FEET)	
RUNWAY 14 and RUNWAY 32 (RDC: D-IV)				
APPROACH RPZ	**RWY 14**	**RWY 32**	**RWY 14**	**RWY 32**
Length	1,700	1,700	2,500	1,700
Inner Width	1,000	500	1,000	1,000
Outer Width	1,510	1,010	1,750	1,510
DEPARTURE RPZ	**RWY 14**	**RWY 32**	**RWY 14**	**RWY 32**
Length	1,700	1,700	1,700	1,700
Inner Width	500	500	500	500
Outer Width	1,010	1,010	1,010	1,010
RUNWAY 2 and RUNWAY 20 (RDC: D-IV)				
APPROACH RPZ	**RWY 2**	**RWY 20**	**RWY 2**	**RWY 20**
Length	2,500	1,700	2,500	1,700
Inner Width	1,000	1,000	1,000	1,000
Outer Width	1,750	1,510	1,750	1,510
DEPARTURE RPZ	**RWY 2**	**RWY 20**	**RWY 2**	**RWY 20**
Length	1,700	1,700	1,700	1,700
Inner Width	500	500	500	500
Outer Width	1,010	1,010	1,010	1,010

Source: FAA AC 150/5300-13B

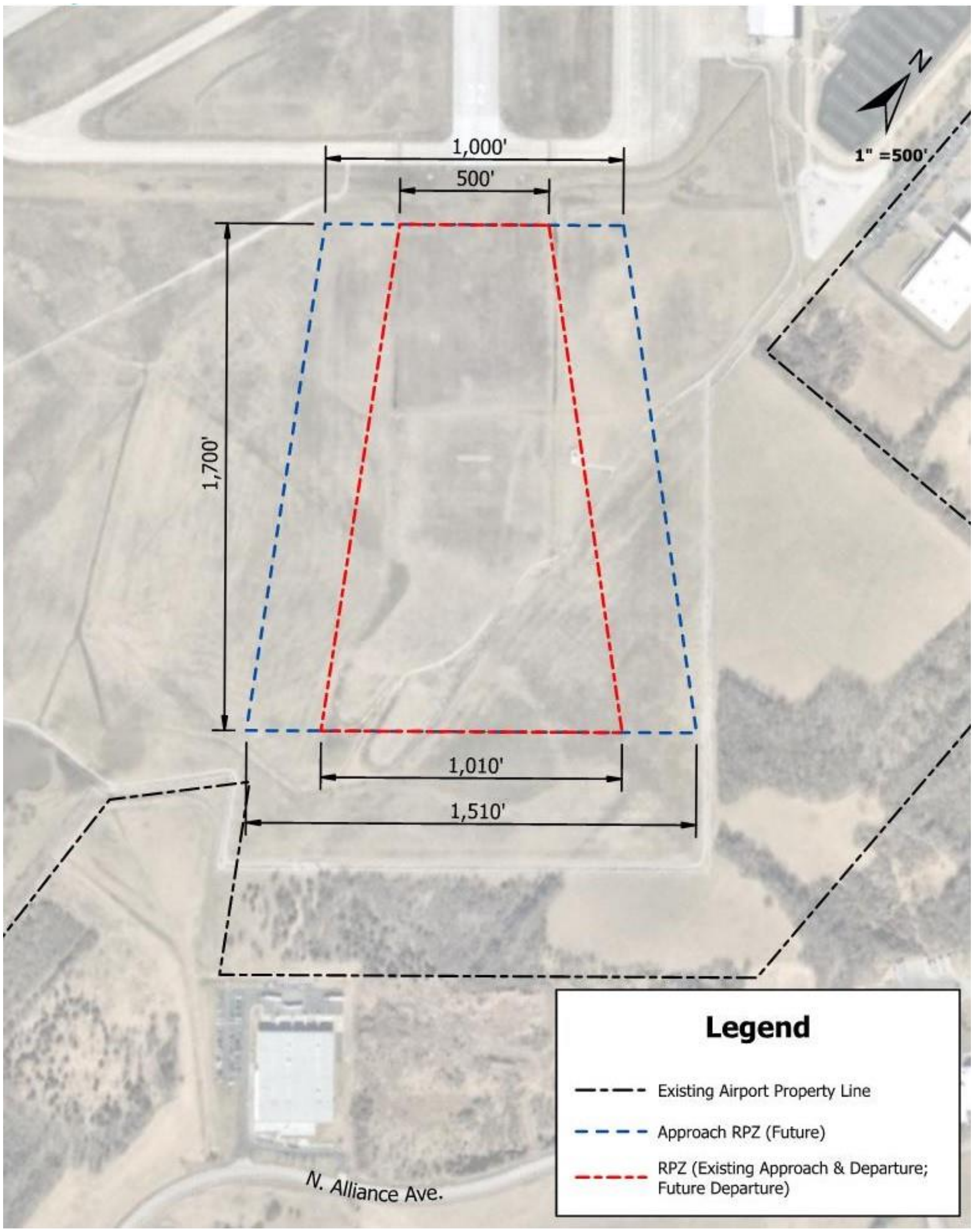
Exhibit 4.2-7: Runway 14 Approach & Departure RPZ



Source: CMT (2022)

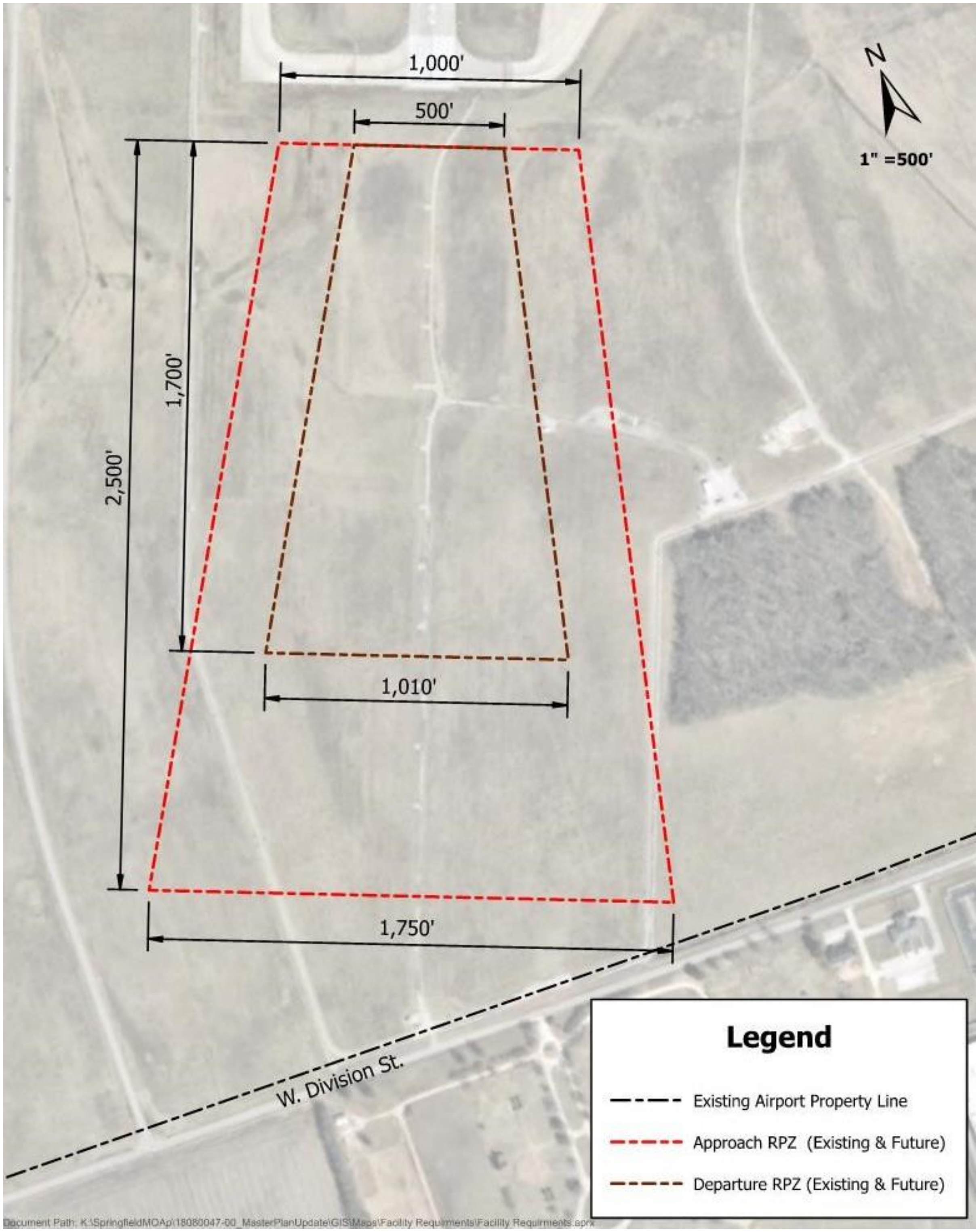
The portion of W Farm Road 104 traversing the Runway 14 Approach RPZ is identified as an incompatible land use. Approximately .38 acres of unowned property exists at the extent of the Future Runway 14 RPZ.

Exhibit 4.2-8: Runway 32 Approach & Departure RPZ



Source: CMT (2022)

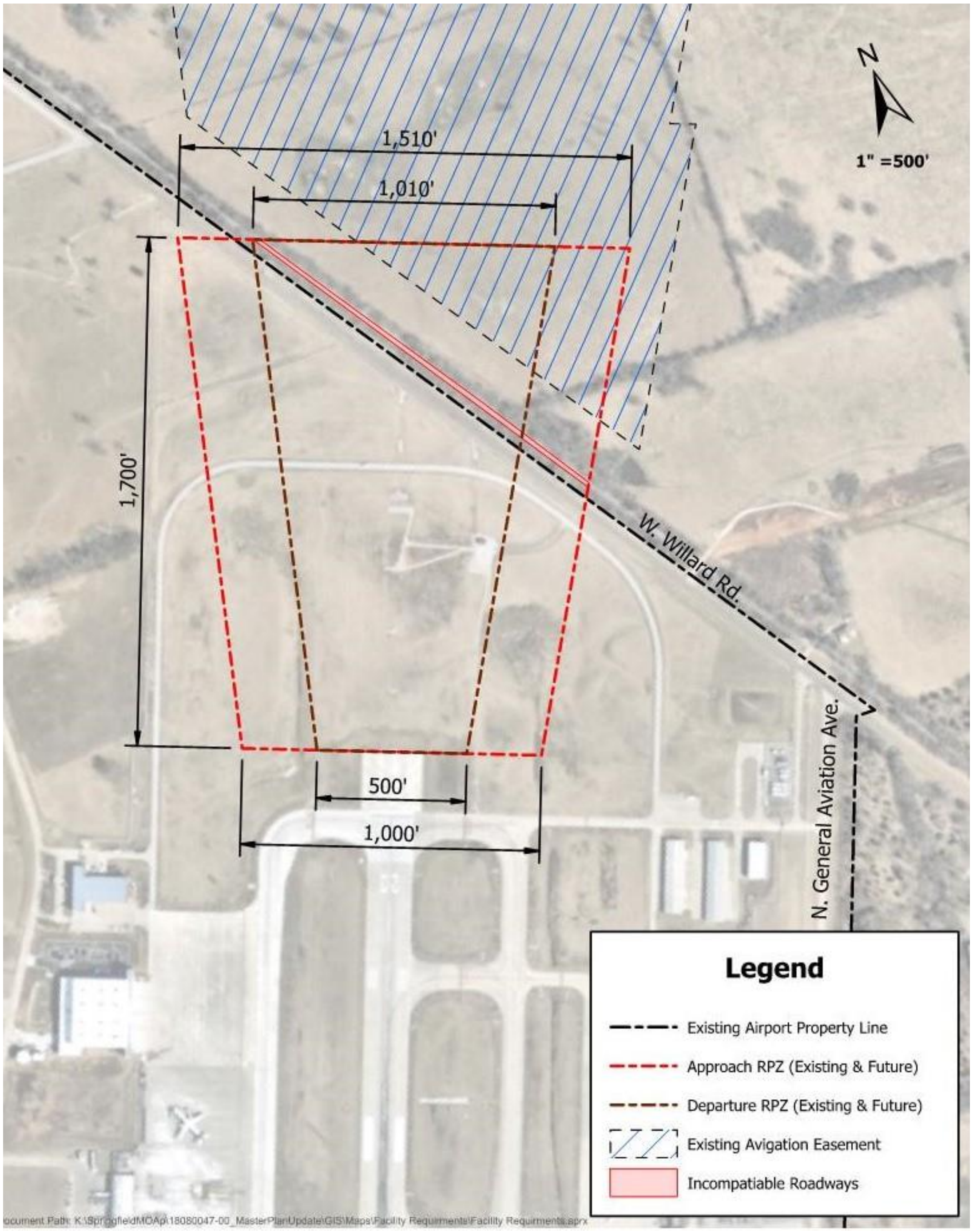
Exhibit 4.2-9: Runway 2 Approach & Departure RPZ



Source: CMT (2022)

No incompatible RPZ land uses are identified.

Exhibit 4.2-10: Runway 20 Approach & Departure RPZ



Source: CMT (2022)

The portion of W Willard Road traversing the Runway 20 Approach and Departure RPZs is identified as an incompatible land use. The Airport possesses an easement to control use of unowned RPZ property north of W Willard Road.

Mitigation of RPZ Incompatibilities

Given that the identified RPZ incompatibilities at SGF are public roads, mitigation or relocation can represent a challenge due to the extensive planning and resources required to relocate a portion of a road. Where practical, Airport owners should own sufficient property interests under the runway approach and departure areas to at least the limits of the RPZ. It is desirable to clear the entire RPZ of all above-ground objects. Where this is impractical, airport owners, as a minimum, should maintain the RPZ clear of all facilities supporting incompatible activities. It is recommended that the Airport monitor activities within each RPZ and continuously work with its neighbors to prevent any incompatible activities and future developments.

If either the Airport or a surrounding municipality considers alternatives to relocate a road that impacts an RPZ, a separate RPZ study may be required.

RUNWAY LENGTH

Based on the assessment provided in **Appendix 10**, the existing 8,000′ length of Runway 14-32 is considered adequate for existing and future users throughout the planning horizon.

The previous Master Plan recommended extending Runway 2-20 to a length of 8,003′. This recommendation will be carried forward as the extra length of Runway 2-20 would provide an extra measure of resiliency during weather, maintenance, and construction events. Per **Table 4.2-8**, the Runway 2 end provides the greatest degree of wind coverage during IFR conditions. Additional length on Runway 2-20 would enhance operational flexibility and efficiency during inclement weather conditions.

4.2.5 Taxiway Design Standards

The FAA defines a runway incursion as "any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle, or person on the protected area of a surface designated for the landing and takeoff of aircraft."[3] In recent years, the FAA has placed special emphasis on the prevention of runway incursions and the maintenance of pilot awareness. FAA AC 150/5300-13B provides the following guidance on how to design taxiways and taxilanes in a way that enhances safety by reducing the probability of runway incursions:

- Keep taxiway systems simple by using the three-path concept. As illustrated in **Exhibit 4.2-11**, the three-path concept means a pilot should have no more than three choices at an intersection (preferably left turn, right turn, and straight).
- Avoid wide expanses of pavement with taxiway-to-runway interfaces. For example, an aircraft parking apron should not be directly connected to a runway by a taxiway.
- Reduce the need for aircraft to cross runways.
- Avoid high-energy area intersections. High-energy intersections are intersections in the middle third of the runway.

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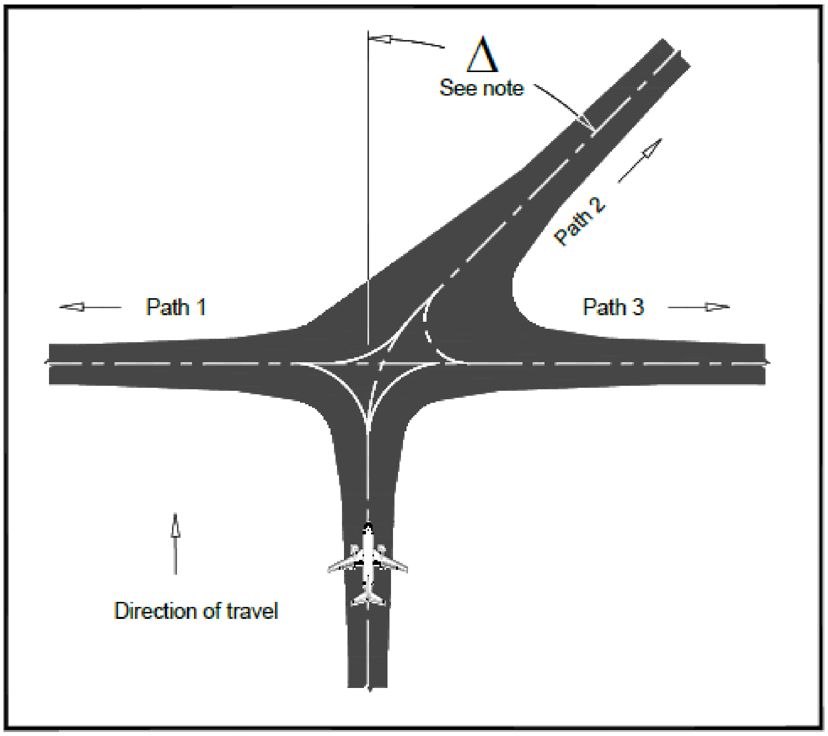
[3] https://www.faa.gov/airports/runway_safety/news/runway_incursions/

- Provide right-angle intersections (between two taxiways and between a taxiway and a runway). Do not use acute angle runway exits as a runway entrance point or as runway crossing.
- Avoid dual-purpose pavements. Do not use runways as taxiways and vice versa.
- Do not construct taxiways that lead directly from an aircraft parking apron to a runway (direct access).

Exhibit 4.2-11: Three-Path Concept Taxiway Intersection



Note: The angle (△) is measured from the initial direction of travel.

Source: FAA Advisory Circular 150/5300-13B

Table 4.2-13 provides an evaluation of the taxiway design standards at SGF. Table 4.2-14 shows the existing and proposed dimensions of the taxiways at SGF, of which all dimensions are compliant with FAA standards.

Table 4.2-13: Taxiway Design Geometry at SGF

TAXIWAY DESIGN STANDARD	RECOMMENDED ACTION	COMPLIANCE
Three-Path Concept: avoid more than three paths at intersections	Avoid	YES
Wide Expanses of Pavement	Avoid	YES
Runway Crossings	Avoid	YES
High-energy Intersections	Limit	NO
Right-angle Intersections	Provide	YES
Dual Purpose Pavements	Avoid	YES
Direct Access to Runways	Avoid	NO

Source: CMT (2022)

TAXIWAY GEOMETRY

Table 4.2-14: Taxiway Design Standards

DESIGN ELEMENT	EXISTING / STANDARD DIMENSIONS (FEET)
ADG-IV	
Taxiway and Taxilane Protection	
TSA (Maximum ADG wingspan)	171
TOFA	243
TLOFA	224
Taxiway and Taxilane Separation	
Taxiway centerline to parallel taxiway centerline	207
Taxiway centerline to fixed or movable object	121.5
Taxilane centerline to parallel taxilane centerline	197.5
Taxilane centerline to fixed or movable object	112
Wingtip Clearance	
Taxiway wingtip clearance	36
Taxilane wingtip clearance	26.5

Source: FAA AC 150/5300-13B

Taxiway design standards are set by the FAA and are a function of the size of aircraft that are intended to use the taxiway. The FAA categorizes taxiways of varying capability using a system like that of the RDC discussed previously in this chapter called Taxiway Design Group (TDG). TDG is based on the dimensions of the aircraft undercarriage. The determining factors are (1) the width of its main gear and (2) the distance between the cockpit and the main gear.

Table 4.2-15 outlines the future taxiway design group dimensions based on the B767-300F aircraft (ADG-IV, TDG 5). SGF currently meets these standards, except for paved taxiway shoulders. Existing taxiway shoulders at SGF consist of stabilized turf, whereas current FAA guidance calls for paved shoulders on taxiways accommodating ADG-IV and larger aircraft. In the past, FAA only recommended paved shoulders for ADG-IV taxiways. The Airport has requested and received FAA approval to omit paved shoulders on recent taxiway reconstruction projects where the result would be a non-continuous shoulder. Installation of paved shoulders should be considered during future taxiway projects.

Table 4.2-15: Parallel Taxiway Design Group Future Dimensions

DESIGN ELEMENT	EXISTING / REQUIRED DIMENSIONS (FEET)	
TDG-5		
Parallel Taxiway/Taxilane Width	60-75	75
Parallel Taxiway Edge Safety Margin	10-14	14
Parallel Taxiway Shoulder Width	0	30

Source: FAA AC 150/5300-13B

All parallel taxiways at SGF are 75' wide and are designed for ADG-IV/TDG-5 aircraft, or aircraft with up to 171-foot wingspans, except the portion of Taxiway N south of Runway 14-32, which is 60' wide. This portion of Taxiway N can accommodate most ADG-IV aircraft, except those in which the cockpit to main gear (CMG) distance and main gear width (MGW) exceeds the values prescribed in AC 150/5300-13B, such as the B767-300F. Consideration should be given to widening this section of Taxiway N to comply with TDG 5 criteria.

The parallel taxiway systems at SGF should continue to be designed and constructed to ADG IV/TDG-5 standards. Connector taxiways into general aviation areas can be designed and constructed to lesser standards (typically ADG-III/TDG 3) based on the aircraft being served.

4.2.6 Airfield Lighting and Pavement Markings

SGF is actively participating in the AC 150/5345-53, *Airport Lighting Equipment Certification Program*, which assists airport sponsors in ensuring the airport lighting equipment meets applicable FAA standards for safety, performance, quality, and standardization.

All existing runway ends are equipped with an Approach Lighting System (ALS) except for Runway 32. It is recommended that all runway ends with non-precision instrument approaches be equipped with at least a Medium Intensity Approach Lighting System (MALS) to enhance visual recognition of the runway end.

One deficiency was found with the airfield pavement markings. It was found that the holding position markings increase the distance of 1 foot for every 100 feet above sea level from a base separation of 250'. This means that the holding position markings at SGF need to be a minimum of 263' from the runway centerline. [4] Three instances of non-compliance are less than 263' at approximately 240' noted in the following **Exhibit 4.2-12**.

It is recommended to bring all holding position markings to the compliant distance of 263' from the runway centerline.

Exhibit 4.2-12: SGF Holding Position Marking Inadequacies

Source: CMT (2022)

[4] Foot note 8- Runway Design Standards Matrix for AC 150/5300-13
Office of Airports

AIRFIELD HOT SPOTS

A "hot spot" is a runway safety-related problem area on an airport that presents increased risk during surface operations. Typically, it is a complex or confusing taxiway/taxiway or taxiway/runway intersection. The area of increased risk has either a history of or potential for runway incursions or surface incidents, due to a variety of causes, such as but not limited to airport layout, traffic flow, airport marking, signage and lighting, situational awareness, and training. Hot spots are depicted on airport diagrams as open circles or polygons designated as "HS 1", "HS 2", etc., and tabulated in the list below with a brief description of each hot spot. Hot spots will remain charted on airport diagrams until such time the increased risk has been reduced or eliminated.[5]

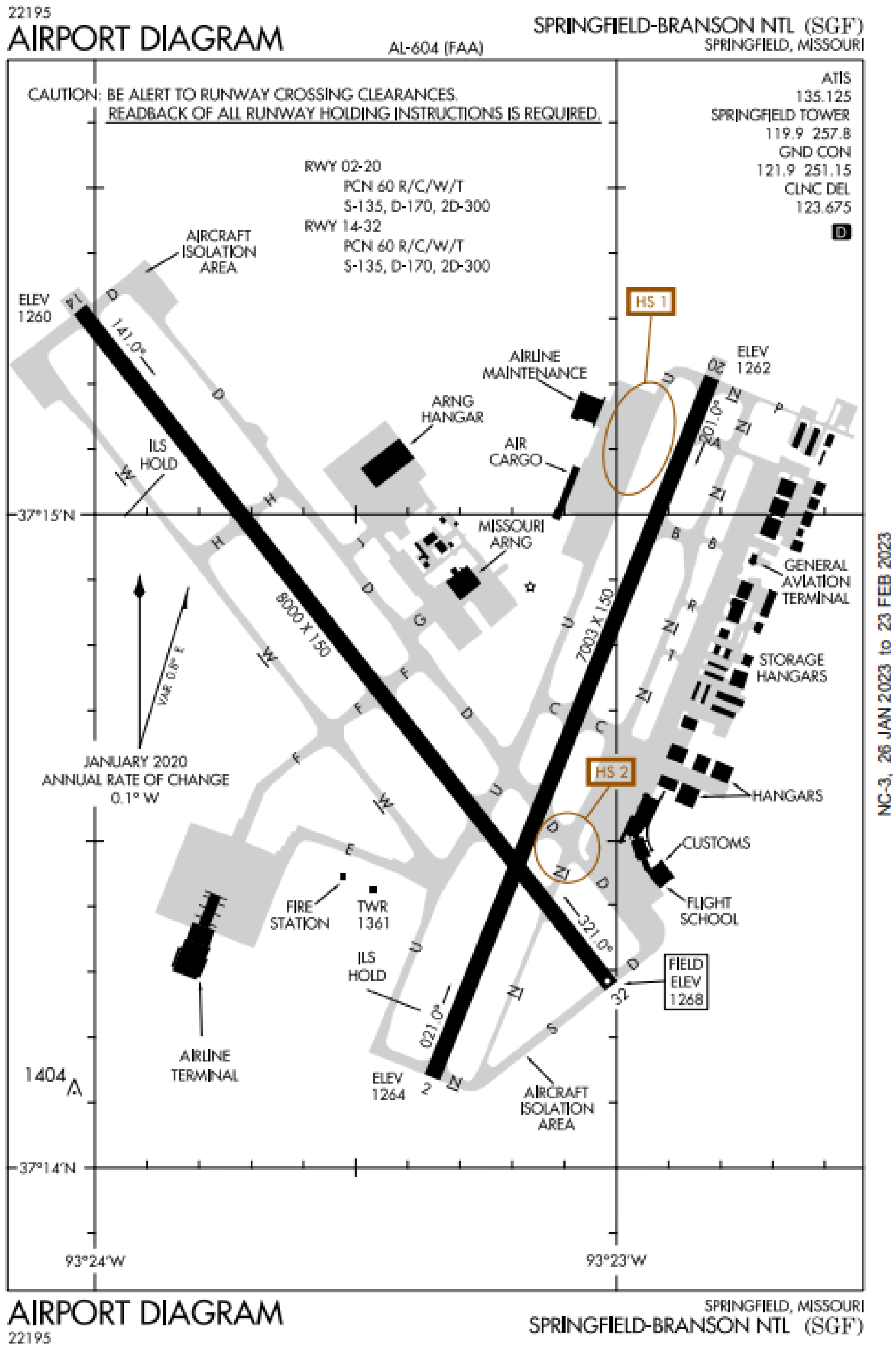
There are two hotspots noted on the Airport diagram at SGF. Those hot spots are as follows:

- HS 1 – Tower blind spot on the movement area.
- HS 2 – Intersection of Taxiway D and Taxiway N is in close proximity to Runway 02-20 and Runway 14-32. Use caution to ensure proper turns to avoid entering the runway without a clearance.

Exhibit 4.2-13, below is the airport diagram showing the location of the hot spots. It is recommended to take action to mitigate these hot spots.

[5] https://aeronav.faa.gov/

Exhibit 4.2-13: SGF Hot Spots



Source: FAA (2023)

4.3 Cargo Operations - Facility Requirements

As described in Chapter Three – *Forecast of Aviation Demand,* cargo operations at SGF have been on a growth trend and are projected to continue growing well into the future.

The preferred forecast for all cargo shows the current operators, UPS and FedEx, upgauging to Boeing 767-300s. This will lower the operating frequency to one flight per day, per operator, as well as account for the addition of another operator, such as Amazon, with an additional operation of a Boeing 737-800 to make a total of three operational frequencies per day.

4.3.1 Cargo Hangars

Hangars are not needed for cargo operations at SGF at this time. Cargo aircraft are not regularly stored at the Airport, leaving cargo hangars out of the picture for the foreseeable future at SGF. The cargo requirements are based on apron space as opposed to hangar space.

4.3.2 Cargo Warehouse

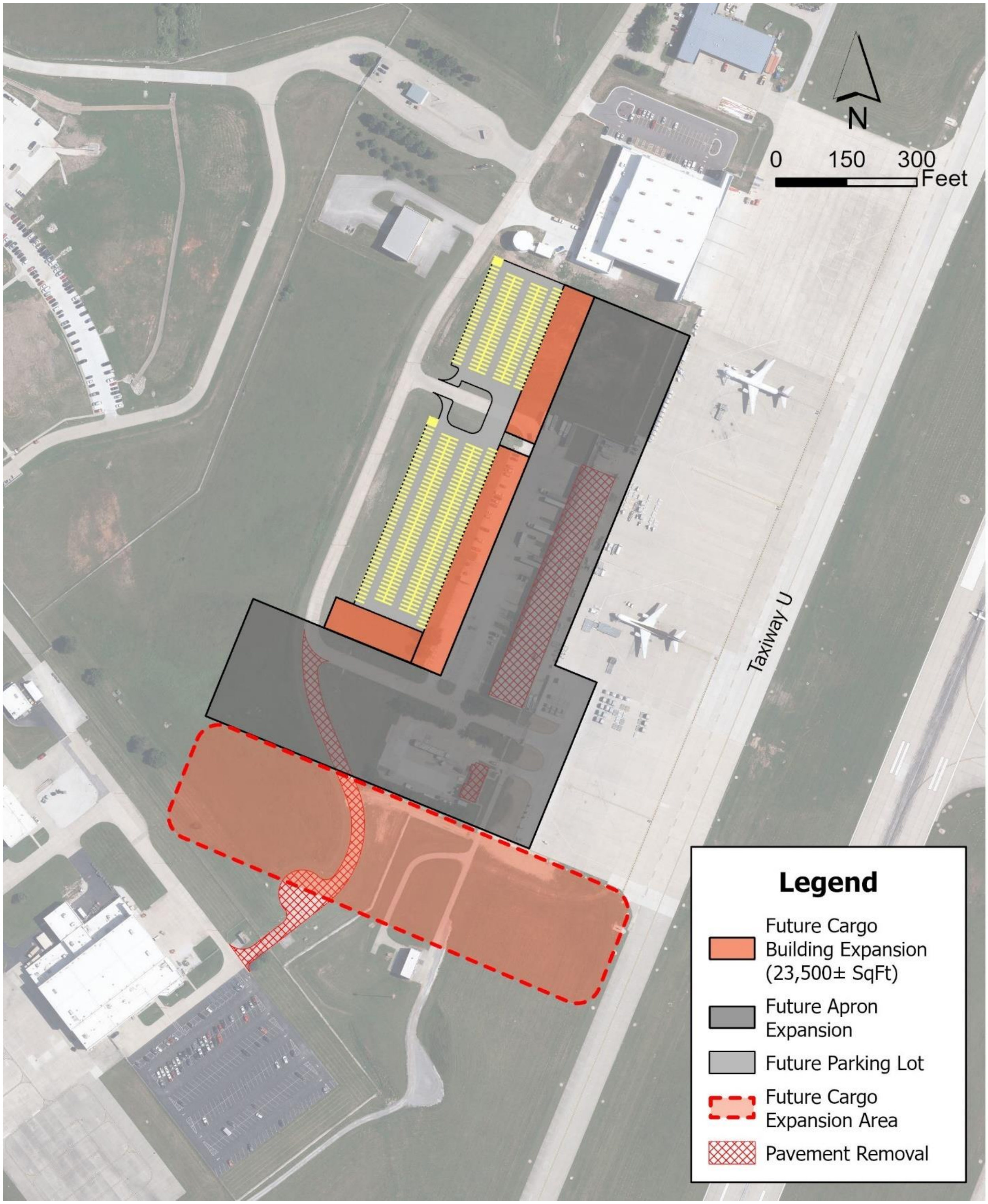
The preferred forecast adds a new all-cargo tenant to the airfield. A facility near SGF could be beneficial to the cargo operators, but a warehouse on airport property is not necessary. The operations of loading docks and bays that transfer the goods have been noted to be appropriate for the cargo operations at SGF by airport staff. Warehousing needs should be assessed as needed with cargo tenants.

4.3.3 Cargo Aprons

The process of an expansion to the southwest corner of the existing Cargo Apron, under the 2021 MoDOT Freight Enhancement Program Grant Proposal, is underway at SGF. The installation of a new nose tether system has also been utilized to reconfigure the pavement markings to accommodate four cargo aircraft parking spaces. The reconfiguration of the apron with the four parking spaces is sufficient for the projected cargo operations forecast.

Exhibit 4.3-1 shows the future Cargo Apron configuration at SGF.

Exhibit 4.3-1: SGF Future Cargo Apron Configuration



Source: CMT (2022)

4.3.4 Bays/Loading Docks

There are currently 20 cargo loading bays split amongst the two existing cargo tenants at SGF. Assuming a new operator, such as Amazon, arrives with similarly sized aircraft and the same frequency as the existing operators, another ten bays of loading docks could be assumed as adequate. Understanding that the current operations of UPS are in the process of upgrading their facility to 20,000 square feet, it would fit the preferred cargo forecast to develop a similarly sized cargo facility for another operator with an additional 20,000 square-foot facility with 10 bays. Offsetting future cargo facility development to the west could provide additional apron depth for cargo operations and, by moving aircraft tails further from Taxiway U, partially mitigating ATCT line-of-sight impacts documented as Hot Spot (HS) 1.

4.4 General Aviation/Corporate - Facility Requirements

4.4.1 Fixed Based Operator (FBO) Terminal

Midwest Premier is the full-service FBO at SGF providing services such as marshaling, tie downs, fueling, deicing, lavatory service, ground power unit (GPU) service, and towing capabilities, as well as ramp shuttle services. The FBO terminal is currently meeting serviceable standards with a façade update and 4,500 square-foot addition planned to be completed in 2024. Exhibit 4.4-1 shows a rendering of the finished GA terminal at SGF.

Exhibit 4.4-1: Midwest Premier FBO Terminal Rendering

Source: SGF, Drake Wells Architecture (Acquired 2022)

4.4.2 General Aviation Hangars

The representative aircraft models shown in **Exhibit 4.4-2** were selected based on SGF's GA fleet mix: the **Cirrus SR-22 Turbo** is one of the most used airframes in the past five years, and the **Cessna Citation CJ2** is one of the most common jets that has utilized SGF facilities in the past (per TFMSC records).

Exhibit 4.4-2: SGF Representative Aircraft Models and Storage Space Required

REPRESENTATIVE AIRCRAFT	
T-Hangar	Box Hangar
S22T - Cirrus SR-22 Turbo	C25A - Cessna Citation CJ2
	
Aircraft Size	
26' x 38' 4" - **996.66 ft²**	47' 8" X 49' 10" – **2,375.38 ft²**

Source: CMT (2022)

To assess the future need for hangar space, the approximate square footage and number of parking positions of each hangar were assessed.

Table 4.4-1: SGF Existing GA T-Hangar Aircraft Storage Capacity

HANGAR	AREA (FEET²)
T-Hangar 11 H	6,500
T-Hangar 11 I	6,500
T-Hangar 11 J	12,800
T-Hangar 11 K	16,185
T-Hangar 11 L	6,430
T-Hangar 11 M	6,430
T-Hangar 12 L	7,560
T-Hangar 12 M	14,250
T-Hangar 12 N	14,290
TOTAL	90,945

Source: CMT (2022)

Table 4.4-1 shows that SGF has an existing T-hangar capacity of 90,945 square feet. The following assumptions were made concerning how each aircraft type will be stored:

- Single-engine aircraft will be stored inside T-hangars.
- Since the representative single-engine airframe requires nearly 1,000 square feet of storage, it is assumed all multi-engine aircraft will be stored inside box hangars.
- Jets will be stored inside box hangars.

Anticipating an additional 27 single-engine aircraft by 2041, there is a **26,910 square foot deficit of T-hangar space**. To visualize the deficit in actual hangar space it could be compared to 2 hangars at the same size as Hangar 17D, which is a 60' x 270' T-hangar (16,200 square feet), or three 10-unit T-hangars.

It was also assumed that any additional based aircraft beyond those currently based at SGF would require additional hangar space as the existing hangars at the Airport are completely occupied. The Airport currently has a waiting list of potential users, operators, and developers who are vying to get hangar space.

Table 4.4-2 below, displays the existing GA box hangar storage capacity at SGF.

Table 4.4-2: SGF Existing GA Box Hangar Aircraft Storage Capacity

HANGAR	AREA (FEET^2)
Box Hangar 11 A	17,700
Box Hangar 11 B	11,665
Box Hangar 11 C	17,700
Box Hangar 11 D	21,865
Box Hangar 11 E	19,600
Box Hangar 11 F	19,600
Box Hangar 11 G	15,350
Box Hangar 11 N	9,860
Box Hangar 11 O	9,115
Box Hangar 11 P	6,000
Box Hangar 11 Q	6,000
Box Hangar 11 R	8,200
Box Hangar 11 S	6,060
Box Hangar 11 U	14,525
Box Hangar II T	42,110
Box Hangar 12 D	22,580
Box Hangar 12 E	23,580
Box Hangar 12 F	23,000
Box Hangar 12 G	9,920
Box Hangar 12 H	4,345
Box Hangar 12 I	11,800
Box Hangar 12 J	9,190
Box Hangar 12 K	11,050
TOTAL	340,815

Source: CMT (2022)

SGF currently has a total of 340,815 square feet of box hangar space to house larger GA aircraft. The based aircraft fleet mix is projected to gain 15 new multiengine aircraft that will require a total of **35,631 square feet of box hangar space** by 2041.

Assuming that all existing hangars are currently operating at full capacity due to the hangar waitlist, **Table 4.4-3** presented below outlines the number of additional based aircraft throughout the planning period; the calculated spatial requirements for these additional based aircraft, taking into account the dimensions of the representative aircraft added to the existing hangar space; and the amount of additional hangar space needed per planning activity level.

Table 4.4-3: SGF Hangar Space Requirements – Total Area

BASED AIRCRAFT FORECAST				
AIRCRAFT TYPE	PAL 1	PAL 2	PAL 3	PAL 4
Single-Engine	99 (+6)	106 (+13)	112 (+19)	120 (+27)
Jet/Multi Engine	44 (+6)	47 (+9)	50 (+12)	53 (+15)
TOTAL SPACE REQUIREMENT (FEET^2)				
AIRCRAFT TYPE	PAL 1	PAL 2	PAL 3	PAL 4
Single-Engine	96,925	103,902	109,882	117,855
Jet	355,067	362,193	369,320	376,446
SURPLUS/DEFICIT (FEET^2) FROM BASELINE				
HANGAR TYPE	PAL 1	PAL 2	PAL 3	PAL 4
T-Hangar	5,980	12,957	18,937	26,910
Box Hangar	14,252	21,378	28,505	35,631
Total Hangar Space	20,232	34,335	47,441	62,541

Note: (+#) is the number of additional aircraft from the 2022 count. Red text indicates a deficit.
Source: CMT (2022)

By PAL 4 an additional 62,541 square feet of hangar space is anticipated. There are several different configurations of hangars that can be placed to accommodate future aircraft that may be demand and or developer driven. For instance, three 10-unit T-hangars would address the T-hangar demand by PAL 4, while four 100'x100' box hangars would create an additional 40,000 square feet of hangar space.

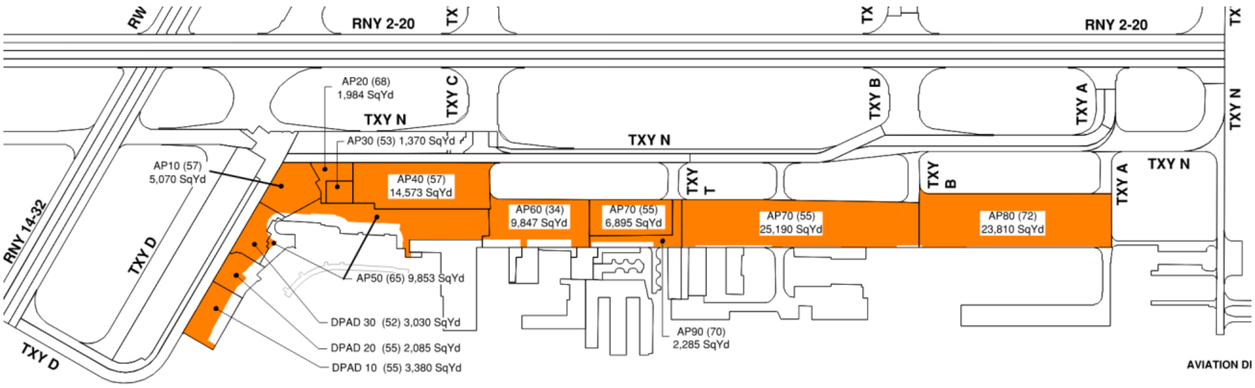
To account for the additional itinerant operations, an additional 200'x200' box or community hangar could provide temporary hangar service to those transient users. The next chapter in this Master Plan will discuss the different alternative configurations of additional hangars at SGF.

4.4.3 General Aviation Aprons

The General Aviation apron at SGF consists of approximately 117,000 square yards of pavement. The northern half of the apron is primarily used for everyday GA use, whereas the southern half of the apron, in front of the West Kearney Terminal building, is primarily used to tie down planes being serviced by the repair stations.

Exhibit 4.4-3 depicts the existing General Aviation apron area. Hangar aprons within 50 feet of a building were excepted from the apron sizing calculations, and an additional 3,000 square yards of existing apron is expected to be removed from operational service to minimize direct apron-to-runway access in the vicinity of Taxiway C. After these adjustments, the apron area used for sizing calculations is 106,372 square yards.

Exhibit 4.4-3: General Aviation Apron Area



Source: CMT (2024)

METHODOLOGY

The methodology employed in the analysis of the GA apron requirements for this Master Plan utilized the spreadsheet model developed by the FAA Central Region for the calculation of apron size for transient aircraft. This model utilizes a two-step method of calculating these requirements:

- Step 1: calculate the area required based on the projections of based aircraft.
- Step 2: calculate the area required based on the projected number of annual GA itinerant operations.

A unique factor affecting apron sizing at SGF is that Maintenance, Repair, and Overhaul (MRO) activities result in the need to stage aircraft that are going through the refurbishment process. Common aircraft types being refurbished include the Saab 340 and 2000, along with the Embraer 120 Brasilia. These aircraft, primarily parked on the southern portion of the GA Apron, take up considerable functional space from other GA Apron needs. The number of aircraft staged for MRO activities varies over time as they are cycled through the refurbishment process. Based on a review of historical activity levels, a conservative estimate suggests a range of between 20 and 25 staged MRO aircraft on the ground at a time.

The MRO activities were projected into the calculator by adjusting the percentage of itinerant operations to parking value. This was done by calculating the number of itinerant aircraft on the ground at a typical 50% parking factor, and then adding 20 aircraft, which is a conservative average number of parked MRO aircraft.

The total annual operations method was employed to determine the GA apron size requirements for SGF. The operational levels utilized as inputs for the apron size calculator tool are shown in **Table 4.4-4**. Additional details about input parameters used in the apron sizing assessment are provided in **Appendix 11**.

Table 4.4-4: SGF GA Operational Levels for Apron Size Calculation

OPERATIONAL LEVEL	PAL 1	PAL 2	PAL 3	PAL 4
Total Based Aircraft	154	164	174	186
Total Itinerant Operations	29,290	32,962	37,095	41,746
Total Annual Operations	40,694	44,509	48,787	53,585
Percentage of Itinerant Operations	72%	74%	76%	78%
Annual Operations during Busiest Month	13.21%			
Busiest Month	July			
# of Aircraft on the Ground	54	58	62	69

Source: CMT (2022)

Table 4.4-5 shows the results obtained with the FAA Central Region Apron Size Calculation spreadsheet.

Table 4.4-5: SGF Apron Size Requirements

APRON REQUIREMENTS	PAL 1	PAL 2	PAL 3	PAL 4
Apron Size Required (yd^2)	89,868	96,991	103,432	115,012
Surplus/Deficit (yd^2)	16,504	9,381	2,940	-8,640

Source: CMT (2022)

As indicated, a need for apron space can be expected at PAL 4. With the 10% size factor added for circulation, as given by the calculator, it can be expected that SGF will need 8,640 square yards of apron space; without the 10% increase, the demand is 104,556 square yards compared to the 106,372 square yards of existing apron.

With the demand for additional GA apron space on the cusp of the planning period, it is likely that redevelopment of areas such as the Kearney Terminal and other areas could absorb some of the demand for apron space. The balance between operational requirements and infrastructure supply can grow sustainably as the apron space currently exists.

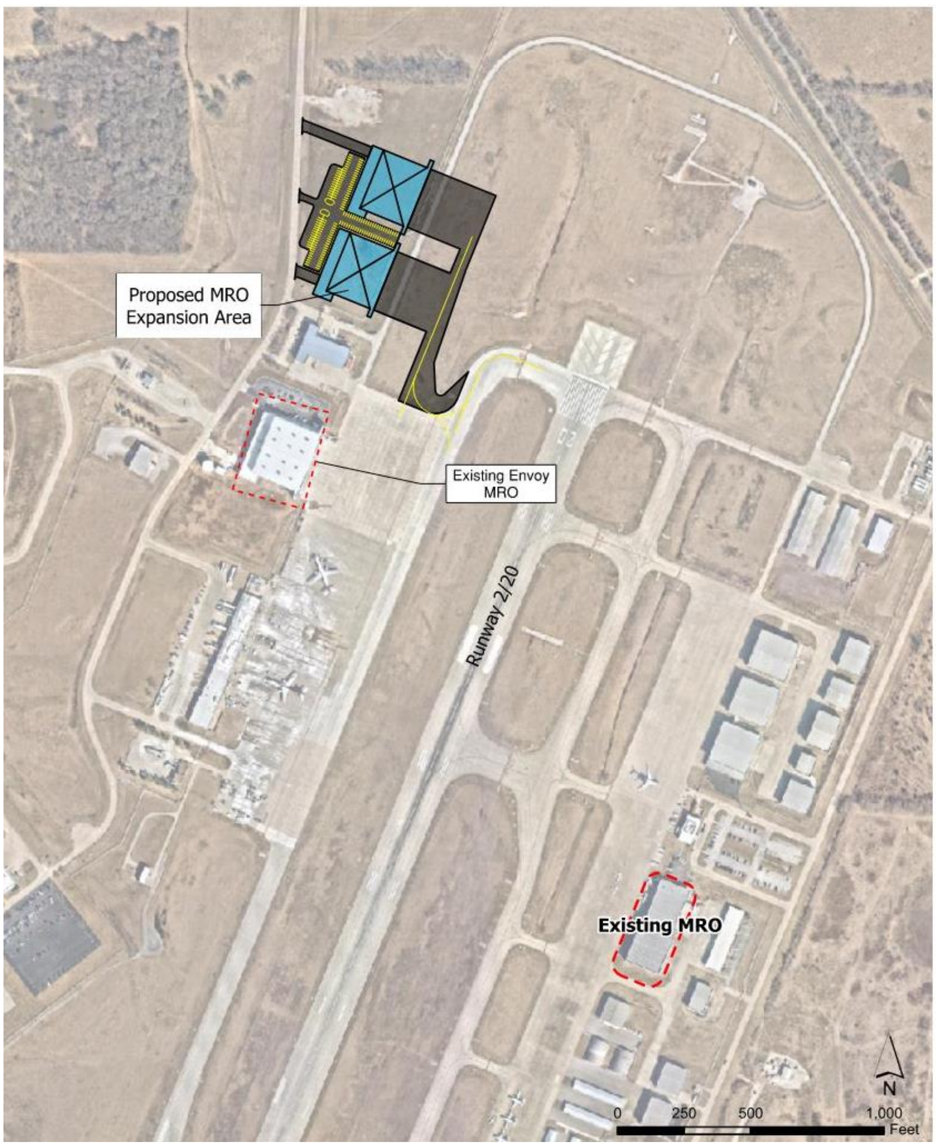
Significant areas of the GA apron are identified as "watch list" pavements in the current Pavement Management Program due to significant distresses or low PCI values. As a result, much of the GA apron is recommended for reconstruction in the 2028 to 2032 timeframe. Decisions about investments in reconstruction of specific apron areas should be made based on operational parameters and documented needs at the time.

4.4.4 Maintenance, Repair, and Overhaul (MRO)

SGF has several MRO operations on the airfield with the largest being Envoy, which services larger commercial jets. Other MRO operators and maintenance providers include Worldwide Aircraft Services, Aviation Enterprises, and Cessna Mobile Service.

Currently, Envoy is located west of the of Runway 20 end and Worldwide Aircraft Services is located south of the GA terminal building, east of Runway 02-20. Consolidation of all MRO buildings to one section of the airfield could be conducive to efficient land use as it would allow for more unified sectors. **Exhibit 4.4-3** shows a preliminary layout of what an expanded and consolidated MRO area could look like.

Exhibit 4.4-4: Preliminary MRO Expansion and Consolidation



Source: CMT (2022)

4.5 Ground Access, Circulation, and Parking

4.5.1 Rental Car Parking

The rental car parking lot has recently been expanded with the addition of a paved overflow lot adding close to 500 new parking spaces. With the recent expansion for a total of 1,475 parking spaces, the capacity is sufficient for the rental demands. There have been reports of wayfinding issues from rental users and possible lot configuration issues. While the wayfinding issue is a somewhat simple problem to overcome with signage, the configuration of the lot may require an independent study to find efficient solutions.

4.5.2 Commercial Terminal Parking

Passenger vehicle parking requirements were calculated for each PAL to determine the adequacy of the existing public commercial terminal parking lots to accommodate the projected demand.

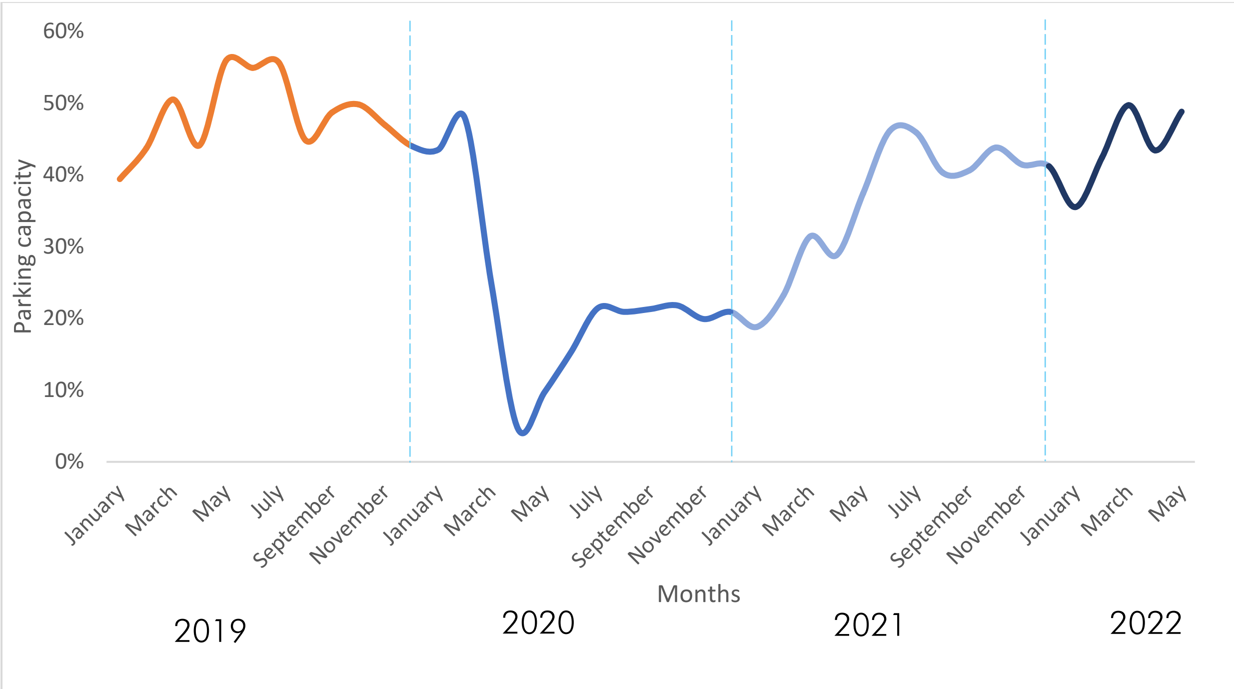
Currently, the Airport offers a total of 2,630 for passenger use, distributed across three parking areas: Short-Term, Long-Term, and Economy Long-Term Parking. Additionally, there is a 32-space cell phone lot and five (5) spaces reserved for pay booth attendants.

Given that the circumstances at each airport are different in terms of how passengers travel to and from the airport and how long their vehicles stay, it was important to understand the relationship between passenger traffic and vehicle parking.

To understand this relationship, parking data was obtained from SP Plus Aviation Services, the parking lot operator, for the period of January 2019 through May 2022 (the maximum data that was available at the time of this analysis). Exhibit 4.5-1 shows the information that was extracted from this set of parking data.

The exhibit below illustrates that COVID-19 had a significant impact on parking utilization with a considerable dip in 2020. To avoid abnormalities caused by the COVID-19 pandemic, 2019 is the most recent benchmark for parking data and the utilization of the parking lot has quickly rebounded to a similar utilization in 2022.

Exhibit 4.5-1: Passenger Parking Utilization at SGF



Source: CMT, SP+ (2022)

As defined in the FAA AC 150/5360-13A, *Airport Terminal Planning,* level of service (LOS) is defined as a qualitative and quantitative measurement of comfort experienced by passengers using the airport passenger terminal facility. LOS is a balance, or compromise, between customer service, cost, and available space. It is a key parameter to address at the onset of the spatial programming process and will be used to understand the passenger parking state at SGF.

LOS is traditionally rated on a scale of A through F, from excellent to unacceptable. This metric has evolved in recent years to simplify the categories "optimum, sub-optimum, under-provided, and over-design" (International Air Transport Association (IATA) Airport Development Reference Manual). Factors that are weighed to determine LOS vary by each terminal element, but can include factors such as processing time, level of crowding, walking distance, climate, etc.[6]

According to the Advisory Circular mentioned above, two key factors for measuring LOS typically considered include **(a)** the ratio of peak period requirements to facility capacity, with a ratio of **85%** typically representing the limit of an acceptable LOS, and **(b)** the proportion of spaces located within an unassisted walking distance of **600 to 800 feet** of a terminal building entrance; ideally with all closed-in spaces located within this walking distance.

[6] Advisory Circular 150/5360-13A, Airport Terminal Planning, 13 July 2018, P. 8.6.3

To reach an optimal level of service for parking, it is important to analyze the existing conditions through the lenses of walkability and circulation.

There are 1,508 parking spaces within 800 feet of the terminal entrance and 697 spaces of those are within 600 feet. Exhibit 4.5-2 below shows two concentric circles, of which the radii are 600 feet and 800 feet from the terminal entrance. The aerial image reflects the expected level of service that users are more likely to utilize as the parking spaces within the circles are visibly more occupied.

Exhibit 4.5-2: Parking LOS at SGF

Source: CMT (2022)

As projected enplanements are expected to increase throughout the planning period, it can also be expected that the demand for parking within 600' and 800' of the terminal entrance will also increase. Parking representatives and operations personnel at SGF have regularly reported that the short-term parking lot closest to the terminal entrance is consistently at capacity.

- The peak parking day of 2019 was May 22nd with 1,902 cars, which makes up 0.41% of parking for the entire year.

Dividing the annual parked car count for 2019 by the annual number of enplanements from 2019 shows the annual parked cars per air passenger which is approximately .79. Applying this annual parked car per passenger measurement to forecasted annual enplanements from the FAA-approved Forecast of Aviation Demand produces a yearly parked car count for future yearly parking demands. The forecasted enplanements are referenced in **Table 4.5-1** below.

To understand what a peak day may look like during each Planning Activity Level, the 2019 peak day car count's ratio of 0.41% can be applied to the expected yearly parked car counts.

To find the number of parking spaces needed to achieve an optimal LOS as defined by the IATA, the projected peak day parking counts are compared to the existing number of parking spaces within 800' of the terminal entrance with an 85% capacity buffer applied to account for comfortable parking circulation. Utilizing the two LOS metrics described by the FAA ensures that the commercial passengers at SGF are experiencing a more than satisfactory level of service at the airport.

Table 4.5-1 below outlines future demands for commercial parking at SGF.

Table 4.5-1: Future Commercial Parking Requirements at SGF

PALs	Preferred Forecasted Enplanements	Projected Annual Car counts	Projected Peak Day Car Counts	Additional Parking Spaces Needed within 800' (To comply with 85% LOS)
PAL 1	601,424	475,378	1,967	807
PAL 2	745,738	589,446	2,439	1,362
PAL 3	814,090	643,473	2,663	1,625
PAL 4	840,018	663,967	2,748	1,725

Source: CMT (2022)

The findings show that over the planning period, an additional 1,725 parking spaces are required within 800' of the terminal entrance to meet the parking demands. While the configuration of these additional parking spaces can take on many forms, one of the most direct would be the construction of a multi-level parking garage.

4.5.3 Cargo Users Vehicle Parking

The cargo facilities parking is mainly established for employee parking and semi-truck accessibility. There are currently approximately **70 parking spaces** (+/- spaces utilized for dumpsters or double spaces for handicapped spaces) It is assumed that with a possible extension of the cargo facility to add another 20,000 square feet and 10 truck bays, there would need to be an additional 25 parking spaces that match the existing development's parking space count to accommodate employees and other uses of the extension.

4.5.4 General Aviation Users Vehicle Parking

There are currently **110 parking spaces** at the GA terminal where primarily the public parks their vehicles. Most of the existing hangars have dedicated spaces for vehicle parking for GA users to conveniently park their vehicles next to where they store their aircraft. Currently, the parking lot at the GA terminal is adequate and is anticipated to have a similar demand as future GA hangars are built with adjacent parking.

4.6 Airport Support Facilities

4.6.1 Fuel Facilities

There are three fuel farms at SGF, two of which are focused on fueling aircraft and the third fuel farm provides fuel to rental cars. Of the two aircraft-supporting fuel facilities, one is in the midfield near the air traffic control tower (ATCT), and the other is on the north side of GA operations. Both locations have three (3) Jet A fuel tanks, each with a capacity of 30,000 gallons and room to add another tank of similar size; the GA fuel farm has two 15,000 Avgas tanks. The total fuel capacity is displayed in **Table 4.6-1** below.

Table 4.6-1: SGF Aircraft Fuel Storage Capacity

FUEL TYPE	CAPACITY (GALLONS)
Jet A	180,000
Avgas	30,000

Source: CMT, SGF (2022)

OBSERVATIONS

Given that the circumstances at each airport are different in terms of how fuel is consumed and dispensed, it is important to understand the relationship between aircraft operations and fuel consumption. To understand this relationship, historical fuel sales data was obtained from the Airport for fiscal years (FY) 2017 to 2021. **Table 4.6-2** shows the historic fuel sales and uplift for each fuel type from FY 2017 to 2021.

Table 4.6-2: SGF Fuel Sale Observations

OBSERVATION	Jet A	Avgas
Percentage of Fleet Mix	54%	46%
Average % of Operations During Busiest Month per Year	11%	11%
Average Annual Operations (2017-2019)	31,912	27,340
Average Annual fuel uplift (gal) (2017-2019)	7,419,904	722,404
Average fuel uplift per operation (gal)	232.51	26.42

Source: SGF, CMT (2022)

ASSUMPTIONS

To determine the future fuel demands per operation at SGF, it is necessary to establish a relationship between the number of projected operations and the number of gallons of fuel required. For this purpose, the following assumptions were established based on accepted industry best practices:

- All commercial operations use Jet A fuel.
- Piston-driven aircraft use Avgas.
- Turbine-driven aircraft use Jet A.
- As most of the operations for the military at SGF are helicopters, it can be assumed that they use Jet A.
- To avoid inconsistencies due to the COVID-19 Pandemic, the historic uplift and peak month data was derived from 2017 through 2019 data.
- 80% of the fuel tank's capacity is "useable" fuel due to overfill prevention, vapor loss, and outlet port locations. [7] For example, a 30,000-gallon tank would only have 24,000 gallons of usable fuel.

Table 4.6-3 below, is the assumptions applied to the data created from Chapter Three

[7] Airport Management Guide for Providing Aircraft Fueling Services (2019) pg. 172

Table 4.6-3: Fuel Use Projections

ASSUMPTION	Existing	PAL 1	PAL 2	PAL 3	PAL 4
Avgas					
Piston Ops from Forecast	23,958	23,757	24,192	24,882	25,810
Avg Fuel Uplift/Operation (gal)	26.42				
Annual Uplift (gal)	633,041	627,730	639,240	657,453	681,973
Daily Uplift (gal)	2,259	2,240	2,282	2,347	2,434
Jet-A					
Jet Ops from Forecast	33,378	40,775	47,534	52,279	56,452
Avg Fuel Uplift/Operation (gal)	232.51				
Annual Fuel Uplift (gal)	7,760,841	9,480,764	11,052,206	12,155,436	13,125,816
Daily Uplift (gal)	26,348	32,188	37,523	41,268	44,563

Source: SGF, CMT (2022)

Using the projections shown in the table above, the existing fuel tank capacity can be compared to the demand.

The target is to have a three-day supply of fuel on hand to satisfy an industry standard. The purpose of this three-day supply is to maintain a continuity of operations in the event of a fuel supply disruption. While the three-day standard is common practice, a five-day fuel supply would account for more inconsistencies in an abnormal supply chain.

Table 4.6-4 below, shows the storage requirements needed for Jet A and Avgas on a three-, five-, and seven-day supply throughout the planning period.

Table 4.6-4: SGF Fuel Storage Requirements

Storage Requirements (GAL)	Existing	PAL 1	PAL 2	PAL 3	PAL 4
Avgas					
3 Day Supply	6,780	6,730	6,850	7,040	7,310
5 Day Supply	11,300	11,210	11,410	11,740	12,180
7 Day Supply	15,820	15,690	15,980	16,430	17,040
Jet A					
3 Day Supply	79,050	96,570	112,590	123,810	133,710
5 Day Supply	131,750	160,950	187,650	206,350	222,850
7 Day Supply	184,450	225,330	262,710	288,890	311,990

Source: CMT (2022)

With the data above being compared to the useable fuel, the surplus or deficit can be deduced. Table 4.6-5 below outlines the difference between the requirements and the existing useable fuel capacity.

Table 4.6-5: Useable Fuel Versus Future Storage Requirements

Storage Requirements (GAL) Surplus or (Deficit)	Existing	PAL 1	PAL 2	PAL 3	PAL 4
Avgas: 24,000 Gal Useable*					
3 Day Supply	17,220	17,270	17,150	16,960	16,690
5 Day Supply	12,700	12,790	12,590	12,260	11,820
7 Day Supply	8,180	8,310	8,020	7,570	6,960
Jet A: 144,000 Gal Useable*					
3 Day Supply	64,950	47,430	31,410	20,190	10,290
5 Day Supply	12,250	(16,950)	(43,650)	(62,350)	(78,850)
7 Day Supply	(40,450)	(81,330)	(118,710)	(144,890)	(167,990)

*Useable fuel is 80% of total fuel capacity
Source: CMT (2022)

As seen in the table above, Jet A and Avgas fuel demands are projected to meet the three-day supply standard with the existing fuel tanks. The Avgas tanks will meet the demands well past the planning period, but additional Jet A fuel tanks will be needed on a five-day supply. This data shows that there is little room for any supply chain inconsistencies or abnormalities.

It is recommended that a 30,000-gallon Jet A fuel tank be added at each PAL to provide the airport with a reliable five-day supply of fuel.

Future space requirements to locate Sustainable Aviation Fuel (SAF), unleaded aviation gas (EAGLE program—Eliminate Aviation Gasoline Lead Emissions), and electric charging stations for electric aircraft were not evaluated as part of this Master Plan Update but should be considered in a future planning study.

4.6.2 Aircraft Rescue & Fire Fighting (ARFF)

14 CFR Part 139 dictates that operators of Part 139 airports must provide ARFF services during air carrier operations that require a Part 139 certificate. One of the requirements of Part 139 establishes that within three minutes from the time of the alarm, at least one required ARFF vehicle must reach the midpoint of the farthest runway serving air carrier aircraft from its assigned post or reach any other specified point of comparable distance on the movement area that is available to air carriers and begin application of the extinguishing agent.

An ARFF Index for the Airport is defined in 14 CFR Part 139.315, Paragraph C, and is determined by the longest air carrier passenger aircraft with an average of five or more daily scheduled departures. However, when there are fewer than five average daily departures of the longest air carrier aircraft serving the Airport, the Index required for the Airport will be the next lower Index group than the Index group prescribed for the longest aircraft. The requirements for Index determination are presented in **Table 4.6-6**.

Table 4.6-6: Airport ARFF Index Determinations

AIRPORT INDEX	LENGTH OF AIRCRAFT (ft)[8]	VEHICLES[9]		EXTINGUISHING AGENTS (gal)[10]	
		LIGHT-WEIGHT	SELF-PROPELLED	DRY CHEMICAL	WATER[11]
A	< 90	1	0	500 or 450	0 or 100
B	90 – 125.9	1	1	500	1,500
C	126 – 158.9	1	2	500	3,000
D	159 – 199.9	1	2	500	4,000
E	200 +	1	2	500	6,000

Source: 14 CFR 139.312, Aircraft Rescue and Firefighting: Index Determination

The ARFF station at SGF is located near the ATCT and can regularly provide an ARFF Index B and can provide an Index C or D upon request between 1100Z and 0600Z (Zulu time). The facility has the capability of increasing the service to provide Index C requirements if there is an increase in daily departures or the length of air carriers increases.

Table 4.6-7 presents the planning assumptions used in the development of these requirements. These planning assumptions were based on industry planning standards for airports of similar size and level of operations. **Exhibit 4.6-1** identifies the path that emergency vehicles would take to reach the midpoint of Runway 02-20 from the ARFF station which is the furthest runway from the station.

Table 4.6-7: ARFF Stations Response Time Assumptions

PLANNING ASSUMPTIONS	VALUE
Straight path speed (mph)	49.7
Turn path speed (mph)	34.7
Alarm to departure (seconds)	40

Source: CMT (2022)

[8] Length of largest aircraft providing an average of five scheduled departures daily.
[9] Light-weight vehicle requirements for Index A are part of the total for Index B-E.
[10] The protein-based agents may be substituted for aqueous film forming foam (AFFF) and the quantities of water shown increased by a factor of 1.5. Dry chemicals in the ratio of 12.7 pounds per gallon of water may be substituted for up to 30 percent of the water specified for AFFF.
[11] Water for protein foam production.

Exhibit 4.6-1: ARFF Station Path

Source: CMT (2022)

The ARFF station has a total response time of **1 minute 34 seconds** based on the previously presented methodologies and assumptions. The results of this analysis indicate that the station complies with Part 139 requirements since the response time to reach the midpoint of Runway 02-20 is less than three minutes.

4.6.3 Snow Removal Equipment (SRE) Storage & Ground Service Equipment Maintenance and Storage

Briefly discussed in the Chapter 1 – *Airport Inventory*, snow removal equipment (SRE) storage is scattered about the airfield in various other facilities. The main SRE facility is an approximately 17,500-square-feet that stores SRE equipment and other general airport maintenance equipment in an estimated 11,000-square-foot warehouse. Taking up approximately 5,500 square feet of space alone are the SRE vehicles. Including the storage of other equipment, ice melt, sand, and space for work bays, the warehouse is pressed for space often leaving little to no room for other equipment such as mower decks and tractors. Storage of some of these vehicles and machinery has been moved to other facilities or even pushed outside of the building into the elements causing quicker deterioration of their conditions. Two shipping containers have been placed next to the building to attempt to relieve some of the space issues.

Summing the square footage of the eastern portion of the building where the main vehicle storage areas are with the bulk of the parking bays comes to approximately 11,200 square feet of vehicle and equipment parking space. Utilizing the equipment safety zone requirements without calculating the existing vehicles buffers the parking within the building by 2,760 square feet leaving 8,440 square feet of parking. Based upon current conditions, the vehicles are not able to be parked 10 feet parallel to other parked vehicles which alone, take up more than 5,500 square feet.

Table 4.6-8 describes the safety zones required for parking SRE vehicles.

Table 4.6-8: Equipment Safety Zones

Minimum Clearances for Equipment Safety Zone (ESZ)				
Parked Equipment (Without Attachments)	5 feet (1.5 m) When next to side walls or other stationary objects.	4 feet (1.2 m) When rear of parked equipment faces a wall or other stationary objects.	10 feet (3 m) Parallel to other parked equipment (parallel parking)	10 feet (3 m) From door opening.
Between moving equipment on dual drive-through lanes				
Moving Equipment on single or dual drive-through lane.*	15 feet (5 m) From parked equipment that includes a safe walk-around zone in front of at least 3 feet (0.9 m).	10 feet (3 m) Small Plows1 10 ft or less (3 m)	14 feet (4.3 m) Intermediate Plows and Small Sweepers 1 Over 10 ft up to 15 ft (3 – 4.6 m)	20 feet (6.1 m) Large Plows and Large Sweepers 1 Over 15 ft up to 22 ft (4.6 – 6.7 m)

* Assumes a 7-ft carrier vehicle width with attachments at 30- degree perpendicular to vehicle body
Source: CMT, FAA AC 150/5220-18A

Calculating the storage requirements described in FAA AC 150/5220-18A produces a total requirement of approximately 21,000 square feet for the general support items, materials, special equipment, and parking buffers. With an estimated 5,500 square feet of vehicles and an existing footprint of 17,500 square feet, there is a **deficit of 3,500 square feet of space**.

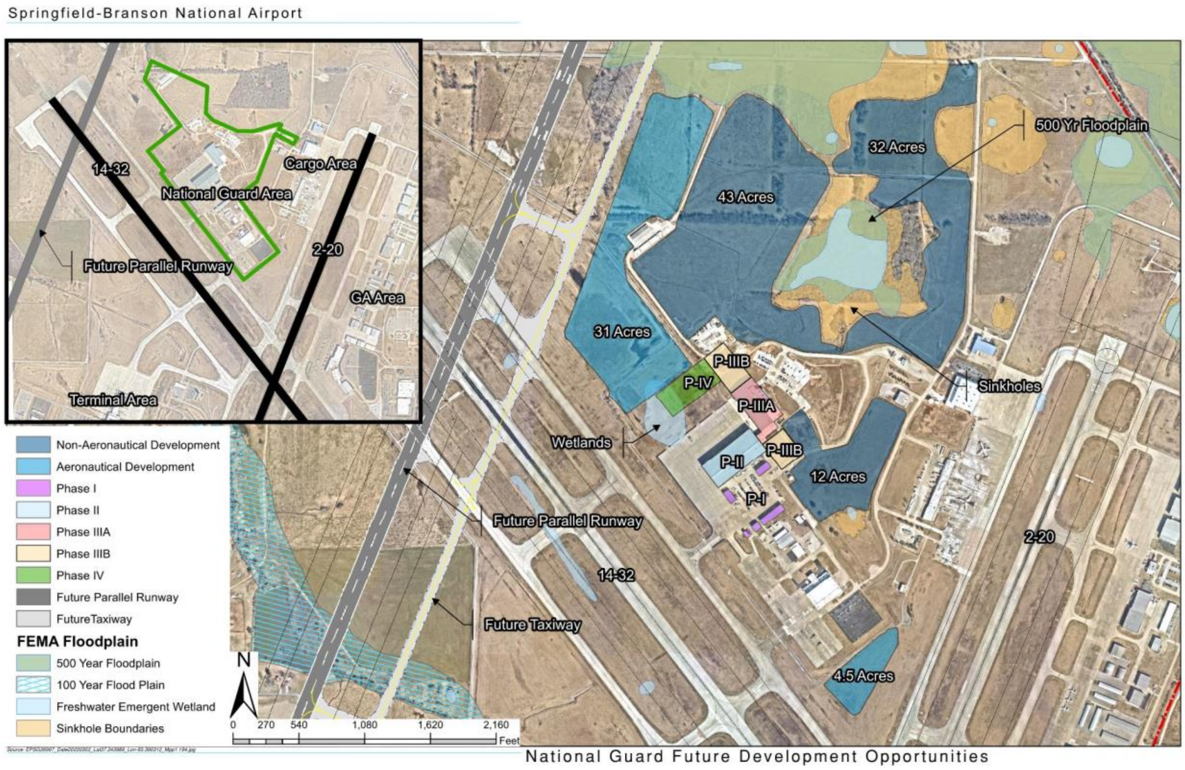
Likely, the storage of bulky pavement condition-treating is not in a specifically dedicated area. It is recommended that a 1,300-square-foot addition or separate permanent building is constructed to accommodate the facility.

An addition to the SRE building could be the reformative solution, the revolutionary solution would be to **relocate the SRE facility** to a new 21,000 square foot facility. The facility must have access to the airfield, but it does not need to be located directly next to the runways. Moving the SRE facility to a location that has a clear path to move the large equipment to the airfield but is not directly adjacent to the runways opens desirable real estate for many other airport users to bring in more revenue. Locations for a new SRE facility will be explored in the Alternatives Chapter of this report.

4.6.4 Missouri National Guard

The Missouri National Guard has intentions of expanding their area of operations at SGF. While the military will conduct a planning study separate from this one, it is important to incorporate the future of the National Guard when discussing SGF's development plan. **Exhibit 4.6-2** shows the possible future areas of military development at SGF.

Exhibit 4.6-2: National Guard Future Development Opportunities at SGF



Source: SGF; CMT (2022)

4.7 Summary of Facility Requirements

Table 4.7-1 provides an overall summary of the net change in facility requirements for the Airport when compared to existing conditions.

Table 4.7-1: SGF Facility Requirements Summary

RESULT	RUNWAY	EXISTING	PAL 1	PAL 2	PAL 3	PAL 4
Airside Requirements						
Runway Wind Coverage – All Weather	All	99.97%	-	-	-	-
Runway Width (ft.)	02-20	150	-	-	-	-
	14-32	150	-	-	-	-
Runway Length (ft.)	02-20	7,003	+ 1,000 (8,003)			
	14-32	8,000	-			
Runway Shoulder (ft.)	02-20	0	+25			
	14-32	0	+25			
Blast Pad Width x Length (ft.)	02	0	+200 x 200			
	20	200 x 200	-			
	14	200 x 200	-			
	32	0	+200 x 200			
RSA & ROFA Incompatibilities	02-20	Wind cones (2), Distance Measuring Equipment (1)	Complete Aeronautical Study or Relocate			
	14-32	Wind cone (1), Distance Measuring Equipment (1), Localizer (1)	Complete Aeronautical Study or Relocate			
Existing Runway Protection Zone (RPZ) Incompatibilities	02	-	Maintain Control and Ownership of Land			
	20	W Willard Rd.	Maintain Control and Ownership of Land			
	14	W Farm Rd 104, unowned land	Maintain Control and Ownership of Land/Acquire Property Interests			
	32	-	Maintain Control and Ownership of Land			
Runway to Parallel Taxiway Separation (ft.)	02-20	400	-			
	14-32	400	-			
Parallel Taxiway Width (ft.)	All	60-75	75			
Parallel Taxiway Shoulder Width (ft.)	All	-	30			
Holding Position Distance	All	3 instances less than 263’	Fix to 263’ from runway centerline			

Source: CMT (2022)

RESULT	RUNWAY	EXISTING		PAL 1	PAL 2	PAL 3	PAL 4
General Aviation (GA)/Corporate Facility Requirements							
GA Hangars Total Area (ft²)	-	T-Hangar	90,945	96,925 (+1 ten-unit Hangar)	103,902 (+1 ten-unit Hangar)	109,882	117,855 (+1 ten-unit Hangar)
		Box Hangar	340,815	355,067 (+ 1 140'x140' Hangar)	362,193	369,320 (+ 1 140'x140' Hangar)	376,446
GA Aviation Aprons Area (yd²)	-	106,372		-	-	-	+ 8,640
Landside Access and Parking Requirements							
GA & Cargo Users Vehicle Parking (spaces)	-	110 (GA)		GA: Locate new parking spaces based on new hangar locations			
		70 (Cargo)		Cargo: +25 spaces based on new facility			
Commercial Users Vehicle Parking (Spaces)	-	2,630		Within 800' of Terminal Entrance			
				+807	+1,362	1,625	+1,725
Airport Support Facilities Requirements							
Fuel Storage – Jet A (gallons)	-	180,000		1 - 30,000-gal tank	1 - 30,000-gal tank	1 - 30,000-gal tank	1 - 30,000-gal tank
Fuel Storage – Avgas (gallons)	-	30,000		-	-	-	-
Aircraft Rescue and Firefighting	-	14,300 square feet of building space		-	-	-	-
Airport Maintenance /SRE Storage (ft²)	-	17,500 square feet of building space		+ 3,500 square feet (construct new 21,000 square foot SRE facility)			

Source: CMT (2022)