C. Facility Requirements

INTRODUCTION

In efforts to determine an airport's future facility needs, it is necessary to translate the forecasted aviation activity into specific physical development requirements. Using the Federal Aviation Administration (FAA) design standards and guidelines, this chapter analyzes the actual types and quantities of facilities and/or the required improvements to existing facilities needed to accommodate the projected demand in a safe and efficient manner. For those components determined to be deficient, the type, size, or number of facilities required to meet the demand is identified and explained using FAA standards and guidelines.

Although the analysis uses the forecasts presented in the previous chapter for establishing future development, it is not intended to dismiss the possibility that either consistently higher or lower growth levels may occur. Aviation activity levels should be monitored for consistency with the forecasts. Since the facility improvements are identified to resolve existing deficiencies, accommodate projected growth, and satisfy airport development goals, the resulting recommendations respond to demand rather than being planned for a specific year.

Airport Design Standards

The geometric design of an airport is based on the Runway Design Code (RDC) standards specified in FAA's Advisory Circular (AC) 150/5300-13B, *Airport Design* and introduced in the previous chapter, **Chapter B – Forecasts of Aviation Activity**. Although the RDC is based on the Critical Aircraft or Design Aircraft defined in AC 150/5000-17, *Critical Aircraft and Regular Use Determination*, and is used for planning and design, it does not limit the aircraft that may be able to operate at an airport. Critical aircraft can take the form of one aircraft or a composite of aircraft representing a collection of aircraft with similar characteristics. FAA AC 150/5300-13B allows for the application of different RDCs to individual runways based on the critical aircraft operating or expected to operate on each runway.

The previous chapter and FAA Forecast Approval Letter contained in **Appendix Three** identified the Runway 17/35 existing critical aircraft as the Embraer ERJ 145, which has a RDC of C-II. The future critical aircraft is identified as the Embraer ERJ 175, which has a RDC of C-III. The Cessna 172 was identified as the Runway 4/22 critical aircraft, which has a RDC of A-I. Since the Cessna 172 has a maximum gross takeoff weight of less than 12,500 pounds, it is considered a small aircraft.

In addition to the aircraft approach speed (AAC) and wingspan components (ADG) comprising the RDC introduced in the previous chapter, a third component exists that is related to the lowest Instrument Approach Procedure (IAP) visibility minimums. An IAP is a series of predetermined maneuvers designed to transition aircraft under instrument flight conditions from the en route portion of the flight to a point where a landing can be made visually. Runways provide maximum utility when they can be used in less-than-ideal weather conditions. This translates to visibility minimums in terms of the distance to see and identify prominent unlighted objects by day and lighted objects by night. Pilots must be able to see the runway or associated lighting at a certain distance from and height above the runway to land during periods of limited visibility. Ultimate runway development should be designed for one of the following visibility categories:

- **Visual –** Runways that support Visual Flight Rules (VFR) operations only, except circle-to-land approaches.
- **Non-Precision Approach (NPA) –** Runways designed to accommodate straight-in approaches with only lateral guidance provided. NPA runways will only support Instrument Flight Rules (IFR) approach operations with visibility minimums of 3/4 mile or greater.
- **Approach Procedure with Vertical Guidance (APV) –** Runways designed to accommodate approaches where the navigation system provides vertical guidance down to 250 feet above the threshold and visibility minimums of 3/4 mile or greater.
- **Precision Approach (PA) –** Runways designed to accommodate approaches where the navigation system provides vertical guidance lower than 250 feet above the threshold and visibility minimums lower than 3/4 mile.

For airport facility geometric design purposes, the instrument approach visibility minimums are expressed as Runway Visual Range (RVR) values in feet. **Table C-1** provides the instrument approach visibility minimums and corresponding RVR value.

Table C-1: RVR Values

Instrument Flight Visibility Minimum Category (miles)	RVR (feet)[1]
Visual	VIS
Not Lower Than 1 Mile	5000
Lower Than 1 Mile but Not Lower Than 3/4 Mile	4000
Lower Than 3/4 Mile but Not Lower Than 1/2 Mile	2400
Lower Than 1/2 Mile but Not Lower Than 1/4 Mile	1600
Lower Than 1/2 Mile	1200

Source: FAA AC 150/5300-13B, *Airport Design*.
Notes: [1] RVR values are not exact equivalents.

As presented in **Chapter A – Inventory of Existing Conditions**, SWO is equipped with an Instrument Landing System (ILS) Instrument Approach Procedure (IAP) and an Area Navigation (RNAV) Global Positioning System (GPS) IAP to Runway End 17 that have visibility minimums as low as 1/2 mile. Runway 4/22 is a visual approach only runway. Therefore, the full expression of the Runway 17/35 existing RDC is C-II-2400 and the Runway 4/22 existing RDC is A-I-VIS (small aircraft only). Future IAP improvements will be evaluated in the next section that will determine the future RDC designations for both runways.

AIRSIDE FACILITY REQUIREMENTS

The analysis of airside facility requirements focuses on the determination of needed facilities and spatial considerations related to the actual operation of aircraft at an airport. The FAA is responsible for the overall safety of civil aviation in the United States. Therefore, the FAA design standards and policy focus first and foremost on safety, with secondary emphasis on efficiency and utility. The evaluation of airside facilities contained in this section includes the application of appropriate design standards to the aircraft operating surfaces (i.e., runways and taxiways), the desired IAP improvements, the sufficiency of the approach areas, and the resulting navigation and lighting needs.

Instrument Approach Procedures and Navigational Aids Analysis

Since many appropriate airport design standards are determined upon the lowest visibility minimums, an evaluation of IAP improvements should be established first that provide an understanding of the benefits received, the implementation required, and the methodology employed.

Instrument Approach Procedures

Increased airport access can be improved by reducing the ceiling and/or visibility minimums associated with IAPs. Further analysis of SWO's climatological conditions presented in **Chapter A – Inventory of Existing Conditions** indicates the existing IAPs to Runway 17/35 are slightly lacking for providing IFR accessibility. As presented in **Table C-2**, the IFR wind analysis indicates that Runway End 35 offers slightly better wind coverage during IFR weather conditions than Runway End 17. Additionally, Runway 17/35 offers less than 95 percent IFR wind coverage for the 10.5-knot crosswind component. Providing at least one IAP to Runway 4/22 would increase the amount of time that smaller aircraft are able to access SWO during excessive crosswind conditions under IFR weather conditions.

The existing Airport Layout Plan (ALP) indicates a future IAP with visibility minimums not lower than 1/2 mile is planned for implementation to Runway End 35. It also shows future IAPs with visibility minimums not lower than 3/4 mile planned for Runway Ends 4 and 22. Therefore, it is recommended that this Master Plan evaluate the possibility of implementing IAPs with lower visibility minimums to Runway Ends 35, 4, or 22 in the next chapter. This would include an evaluation of any required Approach Lighting Systems (ALS).

Table C-2: IFR Wind Coverage by Runway End

Runway	10.5-Knots	13-Knot	16-Knot
17/35	**94.96%**	**97.43%**	**99.15%**
17	67.05%	68.04%	69.57%
35	78.43%	80.23%	81.59%
4/22	**85.84%**	**92.32%**	**97.77%**
4	79.87%	84.72%	88.89%
22	64.12%	67.98%	71.73%
Combined	**97.31%**	**98.92%**	**99.67%**

Source: Mead & Hunt using the FAA Airport Data and Information Portal (ADIP), Wind Analysis. February 2022. Wind data provided by NOAA Integrated Surface Database (ISD), Station 723545. Period of Record 2011-2020.

Navigational Aids

FAA AC 150/5070-6B defines Navigational Aids (NAVAIDs) as aids to navigation that provide pilots with information that assist in locating an airport and to provide horizontal and/or vertical positional guidance during landing. The type, mission, and volume of aeronautical activity, in association with airspace, meteorological conditions, and capacity data determine the need and eligibility for NAVAIDs. NAVAID requirements are based on guidelines contained in FAA Handbook 7031.2C, *Airway Planning Standard Number One* and FAA AC 150/5300-13B, *Airport Design*.

As presented above, Runway 35 is equipped with a ground-based ILS IAP. Two antennae comprise the ILS and work in tandem to provide both vertical and horizontal guidance to approaching aircraft. The localizer antenna provides the horizontal guidance, and the glide slope antenna provides the vertical guidance. The localizer antenna nor of Runway End 35 is located approximately 1,000 feet from the threshold and the glide slope antenna is located approximately 1,170 feet south of the Runway End 17 threshold and 370 feet west of the runway centerline.

A Very High Frequency Omni-Directional Range/Distance Measuring Equipment (VOR-DME) station is located approximately 3.1 miles north/northeast of Runway End 17. This ground-based facility is utilized for en route navigation for airways as well as the NPA IAPs to Runway Ends 17 and 35.

For many years, the FAA has been transitioning away from IAPs that use ground-based NAVAIDS to those that utilize the satellite-based Global Positioning System (GPS). SWO has two PA GPS-based IAPs that have no associated ground-based facilities or equipment. It is anticipated that any future IAP improvements will be implemented using GPS technology and no ground-based NAVAIDS will be utilized at SWO.

Instrument Approach Procedure and Navigational Aids Conclusion

The operational capacity for each runway regarding wind coverage and navigational aids is sufficient to enable an unincumbered system to support existing and future airport operations. However, the ability to implement a GPS-based IAP providing visibility minimums of 1/2 mile to Runway End 35 and NPA IAPs providing visibility minimums not less than 3/4 mile to Runway Ends 4 and 22 would enhance SWO’s access during adverse weather conditions. It is recommended that SWO evaluate the potential to implement these types of IAPs, including the impact on developable area within the terminal area, in the next chapter.

Airfield Design Standards Analysis

Runway Design Standards

Runway design standards are established to assure that runway facilities are designed, constructed, and operated in a safe and efficient manner and represent the minimum standards to be achieved. To determine if existing facilities meet the required standards, this analysis compares the dimensional requirements associated with the appropriate RDC to the existing airport facilities. NAVAIDS classified as fixed-by-function within the Runway Safety Area (RSA) or Runway Object Free Area (ROFA), as listed in Table 6-1 of FAA AC 150/5300-13B, *Airport Design*, are excluded from the analysis.

Runway 17/35

> **Runway Object Free Area (ROFA).** An area centered on the surface of the runway provided to enhance the safety of aircraft operations by remaining clear of objects, except for objects that need to be in the OFA for air navigation or aircraft ground maneuvering purposes. (FAA AC 150/5300-13B, *Airport Design*)

Table C-3 presents the existing dimensions and applicable design standards for Runway 17/35. As contained in the table, Runway 17/35 does not mee the ROFA width dimensional criteria because of two objects. The first is the glideslope equipment building and antenna located 370 feet west of the runway centerline, while the second is a frangible windsock located 250 feet east of the runway centerline. However, the windsock was recently constructed in this location with FAA approval. Therefore, it is not considered an obstruction or non-standard condition within the ROFA. The glideslope equipment building and antenna are non-standard conditions and results in a ROFA width deficiency of 30 feet, providing only a total width of 770 feet.

Table C-3: Runway 17/35 Design Standards

Item	Design Standard (C-III-2400)[1]	Existing Dimensions	
		Runway End 17	Runway End 35
Runway Design			
Runway Width	100'	100'	
Shoulder Width[2]	20'	25'	
Blast Pad Width[2]	140'	N/A	N/A
Blast Pad Length[2]	200'	N/A	N/A
Runway Safety Area (RSA)			
Length Beyond Departure End	1,000'	1,000'	1,000'
Length Prior to Threshold	600'	600'	600'
Width	500'	500'	
Runway Object Free Area (ROFA)			
Length Beyond Departure End	1,000'	1,000'	1,000'
Length Prior to Threshold	600'	600'	600'
Width	800'	**770'**	
Runway Obstacle Free Zone (ROFZ)			
Length	200'	200'	200'
Width[3]	400'	400'	
Runway Separation			
Runway Centerline to:			
Holding Position[4]	260'	260'	
Parallel Taxiway/Taxilane Centerline	400'	400'	

Source: Mead & Hunt analysis using FAA AC 150/5300-13B, *Airport Design*.

Notes: [1] Standards based on aircraft with maximum gross takeoff weight of less than 150,000 pounds.

[2] Paved runway shoulders and blast pads are recommended, but not required for runways accommodating ADG III and below aircraft. Stabilized shoulders of turf are acceptable.

[3] Standard based on 400 feet for operations by large aircraft.

[4] Standard based on 250 feet plus one foot for each 100 feet above sea level (SWO elevation is 1,001 feet).

N/A = Not Applicable.

Bold = Standard not met.

Runway 4/22

Table C-4 presents the existing dimensions and applicable design standards for Runway 4/22. One obstruction, a utility box 80 feet northwest of the runway centerline, is present in both the ROFA and Runway Obstacle Free Zone (ROFZ). This results in a deficiency of 45 feet, providing a total width of only 205 feet for the ROFA and ROFZ.

> **Runway Obstacle Free Zone (ROFZ).** A three-dimensional airspace along the runway and extended runway centerline that is required to be clear of obstacles for protection of aircraft landing or taking off from the runway and for missed approaches. (FAA AC 150/5300-13B, *Airport Design*)

Table C-4: Runway 4/22 Design Standards

Item	Design Standard (A-I-VIS Small)	Existing Dimensions	
		Runway End 4	Runway End 22
Runway Design			
Runway Width	60’	75’	
Shoulder Width[1]	10’	0’	
Blast Pad Width[1]	80’	N/A	N/A
Blast Pad Length[1]	60’	N/A	N/A
Runway Safety Area (RSA)			
Length Beyond Departure End	240’	240’	240’
Length Prior to Threshold	240’	240’	240’
Width	120’	120’	
Runway Object Free Area (ROFA)			
Length Beyond Departure End	240’	240’	240’
Length Prior to Threshold	240’	240’	240’
Width	250’	**205’**	
Runway Obstacle Free Zone (ROFZ)			
Length	200’	200’	200’
Width[2]	250’	**205’**	
Runway Separation			
Runway Centerline to:			
Holding Position	125’	200’	
Parallel Taxiway/Taxilane Centerline	150’	240’ +	

Source: Mead & Hunt analysis using FAA AC 150/5300-13B, *Airport Design*.

Notes: [1] Paved runway shoulders and blast pads are recommended, but not required for runways accommodating ADG III and below aircraft. Stabilized shoulders of turf are acceptable.

[2] Standard based on 250 feet for operations by small aircraft with approach speeds of 50 knots or more.

N/A = Not Applicable.

Bold = Standard not met.

Runway Design Standards Conclusion

Most of the runway design standards for each of SWO’s two runways are met. However, deficiencies in the Runway 17/35 ROFA width and the width of both the ROFA and ROFZ of Runway 4/22 were noted and are shown in **Figure C-1**. Alternatives addressing the ROFA and ROFZ width deficiencies will be considered in the next chapter.

Figure C-1: Runway Dimensional Standard Deficiencies

Runway Line of Sight

Line of sight standards exist to allow pilots to observe runway and taxiway surfaces for assurance that they are clear of aircraft, vehicle, wildlife, and other hazardous objects. According to the longitudinal (i.e., along the length of the runway) line of sight standards contained in FAA AC 150/5300-13B, any two points located five feet above the runway centerline must be mutually visible for the entire length of the runway. However, if the runway is served by a full-length parallel taxiway, the requirement is reduced to one half the runway length.

The longitudinal profile evaluation from each end of Runway 17/35 and 4/22 to the individual runway midpoint at five feet above the runway surface indicates a clear line of sight is achieved. Both Runway 17/35 and 4/22 have an overall longitudinal gradient of approximately 0.48 percent.

When airfield geometry includes intersecting runways, line of sight standards indicate that there must be an unobstructed view from any point five feet above the runway centerline to any other point five feet above the intersecting runway within the Runway Visibility Zone (RVZ). At SWO, the RVZ is defined as an area formed by the imaginary lines connecting the two runways' line of sight points. Because all runway ends are more than 1,500 feet from the runway intersection, the line of sight points are established one-half the distance from the intersecting runway centerline to the runway ends. An analysis was conducted using SWO's GIS survey data collected in 2021 and no obstructions to the RVZ line of sight were found.

Runway Line of Sight Conclusion

The analysis indicated there were no identified line of sight deficiencies for either Runway 17/35 or 4/22.

Pavement Strength

FAA pavement design considers the pavement strength needed to accommodate the expected aircraft fleet to frequently use the pavement. No single critical aircraft is designated for pavement strength. Pavement design strength does not necessarily prohibit airport use by heavier aircraft. However, if routine use by an aircraft heavier than the pavement strength is anticipated, then it would be recommended that pavement strength be increased.

As identified in **Chapter A – Inventory of Existing Conditions**, the pavement of Runway 17/35 and 4/22 is rated in good condition. It should be noted that portions of Runway 17/35 were most recently reconstructed between 2001 and 2009, while a full-depth rehabilitation of Runway 4/22 occurred in 2018. SWO noted a need for rehabilitation on both runways, with minor cracks requiring sealing followed by remarking of the runways. A series of full depth repairs on various runway shoulder areas and edges is anticipated.

SWO's aprons remain in good condition, with SWO staff noting the pavement around T-hangar 2 is exhibiting signs of wear that might need to be addressed, but overall no major pavement improvements are anticipated. The following taxiways were noted for crack sealing and remarking:

- Taxiway A
- Taxiways A1 through A4
- Taxiway B
- Taxiway D
- Taxiway E
- Taxiways F and F1

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Pavement Strength Conclusion

Information provided by airport staff indicates that the pavement strength of the runways, taxiways, and aprons remain generally suitable for the SWO fleet mix. Apron surrounding T-hangar 2 will be monitored for wear and pavement rehabilitation programmed as needed.

Runway Length Analysis

The runway length analysis recommends the length necessary to meet existing and future aircraft demands. The analysis considers aircraft design characteristics, airport elevation, temperature, and destinations, among other factors. The detailed runway length methodology and analysis is contained in **Appendix Four**.

Runway Length Methodology

The determination of runway recommendations for airport planning purposes uses the methodology found in FAA AC 150/5325-4B, *Runway Length Requirements*. This AC states the design objective for primary runways is to provide a runway length for all aircraft that will regularly use the runway without causing operational weight restrictions. AC 150/5000-17, *Critical Aircraft and Regular Use Determination* defines regular use as 500 annual operations, excluding touch-and-go local operations.

Runway 17/35 serves air carrier and the full range of general aviation (GA) aircraft. Runway 4/22 serves primarily smaller GA aircraft. The existing design aircraft (and most demanding aircraft) for Runway 17/35 has been determined to be the Embraer ERJ 145. The future design aircraft (and most demanding aircraft) is the Embraer ERJ 175. The existing and future design aircraft (and most demanding aircraft) for Runway 4/22 has been determined to be the 95 percent family grouping of small aircraft (i.e., aircraft with maximum takeoff weight equal to or less than 12,500 pounds) that have approach speeds greater than 50 knots but have less than 10 passenger seats excluding crew (i.e., pilot and copilot).

Runway Length Analysis

The runway length analysis uses the takeoff performance table and payload and range charts contained in the Airport Planning Manuals (APMs) of the design aircraft. The APMs base aircraft performance on airport temperature and elevation. SWO has an airport elevation of 1,000 feet above mean sea level (AMSL) and a mean maximum temperature of the hottest month of 94 degrees Fahrenheit. Combined, SWO's Density Altitude (DA) is calculated at 3,400 feet AMSL. **Table C-5** presents SWO's recommended runway lengths.

Table C-5: Runway Length Recommendations

Runway	Recommended Runway Length
17/35	**7,401' Actual**
Existing Design Aircraft (E-145)	8,630' (MTOW)
Future Design Aircraft (E-175)	9,430' (MTOW)
4/22	**5,004' Actual**
Existing and Future Design Aircraft (C 172)	3,730'

Source: Mead & Hunt using airport planning manuals and FAA AC 150/5325-4B methodology.

Aircraft have different ranges depending on the amount of weight carried. The recommended runway length will vary based on payload (i.e., passengers, baggage, and cargo), fuel load, and destinations as described by stage length in nautical miles (NMs). The longer the stage length, the more fuel that is required. The amount of fuel required to reach a given destination determines if payload restrictions are required. As stated in **Chapter B – Forecasts of Aviation Activity**, Envoy Airlines currently provides service to Dallas Fort Worth International Airport (DFW) and the most likely long-term future destinations to be served by air carriers are Denver International Airport (DEN) and Chicago O'Hare International Airport (ORD). DFW, DEN, and ORD are located approximately 200, 225, and 550 NMs from SWO, respectively.

Runway Length Conclusion

The runway length analysis suggests that Runway 17/35, with an existing length of 7,401 feet is slightly insufficient to accommodate both the existing and future design aircraft operating at MTOW. However, neither the Embraer ERJ 145 nor the ERJ 175 experience payload restrictions until stage lengths of 650 and 1,300 NMs, respectively, are required. Therefore, the existing Runway 17/35 length is determined to be sufficient, and no runway extensions are recommended.

Runway Protection Zones

Runway Protection Zones (RPZs) are trapezoidal areas beginning 200 feet beyond the threshold of a runway; their dimensions are determined by function (i.e., approach or departure RPZ), critical aircraft size, and the appropriate AAC; and the lowest IAP visibility minimums. Their purpose is to enhance the protection of people and property on the ground. This is accomplished through airport control of the RPZ areas, preferably exercised through fee simple ownership by the airport sponsor. It is desirable to clear all above ground objects from within RPZs. Where this is impractical, airport sponsors should work with property owners to maintain the RPZ clear of all facilities supporting incompatible activities. In consideration of the existing IAP visibility minimums and aircraft type the runways are designed to accommodate, **Table C-6** provides a comparison of the existing RPZ dimensions at PUB and the FAA's specified RPZ dimensional requirements.

Table C-6: Runway Protection Zone Dimension Criteria

Item	Inner Width	Length	Outer Width	Airport Controls Entire RPZ
Runway 17/35				
17 (Approach)	1,000’	2,500'	1,750’	Yes
17 (Departure)	500’	1,700’	1,010’	Yes
35 (Approach)	1,000’	1,700’	1,510’	Yes
35 (Departure)	500’	1,700’	1,010’	Yes
Runway 4/22				
4 (Approach)	250’	1,000’	450’	Yes
4 (Departure)	250’	1,000’	450’	Yes
22 (Approach)	250’	1,000’	450’	Yes
22 (Departure)	250’	1,000’	450’	Yes

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

Runway Protection Zone Conclusion

SWO currently owns all the property within the existing RPZs. Any changes to RPZs in the future will be analyzed in the next chapter.

Runway End Siting Surfaces

FAA AC 150/5300-13B provides criteria for the proper siting of runway ends and thresholds. The criteria are in the form of imaginary evaluation surfaces that are typically trapezoidal shaped and extend away from the runway ends along the centerline at specific slopes, expressed in horizontal feet by vertical feet (e.g., a 20:1 slope rises one foot vertically for every 20 feet horizontally). The specific size, slope, and starting point of the trapezoid depends upon the visibility minimums and the type of IAP associated with the runway end.

Approach Surfaces

Thresholds are located to provide proper clearance over obstacles for landing aircraft on approach to a runway end. When an object penetrates the approach surface required for aircraft to land at the beginning of the runway, and it is beyond the airport sponsor’s ability to remove, relocate, or lower, the landing threshold may require a location other than the end of the pavement (i.e., a displaced threshold). The existing criteria and analysis prepared for SWO are presented in **Table C-7**. According to this analysis there are no obstructions to the threshold siting surfaces.

Table C-7: Approach Surface Dimensions

Runway End	Distance From Runway End	Inner Width	Length	Outer Width	Slope	Existing Obstructions
17	200’	400’	10,000’	3,400’	34:1	None
35	200’	400’	10,000’	3,400’	20:1	None
4	0’	250’	5,000’	700’	20:1	None
22	0’	250’	5,000’	700’’	20:1	None

Source: Mead & Hunt analysis using FAA AC 150/5300-13B, *Airport Design*.

IAPs With Vertical Guidance Surfaces

Runway ends equipped with IAPs providing vertical guidance require an additional level of approach surface analysis. When objects penetrate this imaginary surface that cannot be mitigated, then an approach with vertical guidance is not authorized. The size, shape, slope, and criteria for these surfaces, and the analysis conducted for Runway Ends 17 and 35 are presented in **Table C-8**. Runway Ends 17 and 35 are the only runway ends currently equipped with IAPs providing vertical guidance. There are no objects that penetrate these surfaces.

Table C-8: IAPs With Vertical Guidance Threshold Siting Surface Dimensions

Runway End	Distance From Runway End	Inner Width	Length	Outer Width	Slope	Existing Obstructions
17	0’	300	10,200’	1,520’	30:1	None
35	0’	300	10,200’	1,520’	30:1	None

Source: Mead & Hunt analysis using FAA AC 150/5300-13B, *Airport Design*.

Departure Surfaces

Departure ends of runways normally mark the end of the full-strength runway pavement available and suitable for departures. Departure surfaces, when clear of obstacles, allow pilots to follow standard departure procedures. If obstacles penetrate the departure surface, then the obstacles must be evaluated through the Obstruction Evaluation/Airport Airspace Analysis (OE/AAA) process. After the OE/AAA process, departure procedure amendments such as non-standard climb rates, non-standard (higher) departure minimums, or a reduction in the length of takeoff distance available may be required. The size, shape, slope, and criteria of the departure surfaces, as well as the analysis conducted for Runway Ends 17 and 35 are presented in **Table C-9**. No obstructions were observed in the analysis of the departure surfaces.

Table C-9: Departure Runway Surface Dimensions

Runway End	Distance From Departure Runway End	Inner Width Section One	Inner Width Section Two	Length	Outer Width	Slope	Existing Obstructions
17	0’	100’	450’	12,152’	7,512’	40:1	None
35	0’	100’	450’	12,152’	7,512’	40:1	None

Source: Mead & Hunt analysis using FAA AC 150/5300-13B, *Airport Design*.

Runway End Siting Conclusion

There were no obstructions identified in the existing approach surfaces, IAP with vertical guidance evaluation, or departure surfaces. Should any improvements or changes to the existing IAPs be proposed or the location of any runway thresholds change, then additional runway end siting analysis will be required.

Pavement Marking, Lighting, and Signage

The minimum requirements for surface marking schemes used for runways are a direct function of the approach category for each runway end.

Runway and Taxiway Markings

Runway 17/35 is provided with white precision markings consisting of landing designator numbers, centerline, threshold markings, aiming points, touchdown zone, and edge markings. The markings are consistent with the requirements of runways having precision IAPs. The markings are outlined in black to enhance the contrast with the concrete pavement and are in good condition. Yellow angled shoulder markings are provided between the edge markings and the pavement edge for additional delineation of the runway shoulders as unusable runway pavement.

Runway 4/22 is provided with white basic markings consisting of landing designator numbers, centerline, and aiming points. The markings exceed the requirements of runways with visual only approaches and are in good condition.

All taxiways at SWO are provided with yellow centerline markings. Taxiways that intersect a runway are provided with holding position markings, surface painted holding position signs, and enhanced centerline markings. The surface painted holding position signs and enhanced centerline markings are supplemental visual cues to alert pilots of an upcoming holding position marking in efforts to minimize potential runway incursions. Taxiway markings located on concrete pavements are outlined in black to enhance the contrast with the concrete. The taxiway markings at SWO meet all requirements for Part 139 airports.

Runway and Taxiway Lighting

Runway 17/35 is equipped with Medium Intensity Runway Lights (MIRL) and four-box Precision Approach Path Indicator (PAPI) at each runway end. Runway End 35 is equipped with Runway End Identifier Lights (REILs) and Runway End 17 has a Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR). Runway 4/22 is equipped with MIRL and four-box PAPI. These lighting systems are consistent with the existing IAP visibility minimums requirements and recommendations. If an IAP with visibility minimums lower than 3/4 mile is implemented to Runway End 35, then AC 150/5300-13B indicates a full approach light system, such as a MALSR, would be required.

All taxiways providing access to the runway system at SWO are equipped with Medium Intensity Taxiway Lights (MITL). This practice is recommended for any additional taxiways serving the runway system.

Runway and Taxiway Signage

Both Runways 17/35 and 4/22 have distance remaining signs, which is consistent with requirements of airports frequented by turbojet aircraft as contained in FAA AC 150/5340-18G, *Standards for Airport Signs Systems*. The taxiway signage, consisting of runway entry hold signs, taxiway location signs, and taxiway directional signs is consistent with requirements for Part 139 airports.

Pavement Marking, Lighting, and Signage Conclusion

In conjunction with the Runway End 35 potential IAP improvement of visibility minimums to 1/2 mile mentioned above, it is recommended that SWO evaluate the potential installation of a full approach light system such as a MALSR. Likewise, if a NPA is implemented to either Runway End 4 or 22, then non-precision threshold markings would be required. It is recommended that LED edge lighting replace all existing incandescent lighting.

Taxiway/Taxilane System

Taxiways provide defined movement corridors for aircraft between the runway system and the various functional landside areas on an airport. Some taxiways are necessary simply to provide access between aircraft parking aprons and runways, whereas other taxiways become necessary to provide more efficient and safer use of the airfield. Parallel taxiways eliminate the use of a runway for taxiing, referred to as back taxiing, which increases an airport's capacity and protects the runway under low visibility conditions. Taxiway turns and intersections are designed for safe and efficient taxiing by aircraft while minimizing excess pavement.

Taxilanes are provided for low speed, precis taxiing of aircraft that are usually, but not always, located outside the aircraft movement area. They normally provide aircraft access from taxiways to apron parking positions or hangar areas.

Taxiway/Taxilane Design Standards

Taxiways and taxilanes are designed for cockpit over centerline taxiing, with enough pavement width to allow for a certain amount of wander. Potential runway incursions should be minimized by using design criteria contained in FAA AC 150/5300-13B. Taxiway and taxilane clearance standards are based on wingspan and wingtip clearance criteria determined by the ADG of the critical aircraft. Taxiway and taxilane pavement design standards are based on the landing gear dimension determined by the Taxiway Design Group (TDG).

SWO's existing critical aircraft, the Embraer ERJ 145, has an ADG designation of II and a TDG designation of 2. The future critical aircraft (Embraer E 175) has an ADG III and TDG 3 designation, so the design standards associated with ADG III and TDG 3 will be evaluated for taxiways serving Runway 17/35. **Table C-10** presents the design criteria, design standards, and existing conditions for taxiways serving Runway 17/35.

Table C-10: Taxiway Design Standards for Taxiways Serving Runway 17/35

Design Criteria	Design Standard		Existing Dimension		
			Taxiway A	Taxiways A1 – A4	Taxiway B
ADG Design Criteria	**II**	**III**			
Taxiway Safety Area Width	79’	118’	118’	118’	118’
Taxiway Object Free Area Width	124’	171’	186’	186’	186’
Taxiway Centerline to:					
Parallel Taxiway/Taxilane Centerline	102’	144’	N/A	600’ +	1,350’ +
Fixed or Movable Object	62’	85.5’	93’	93’	93’
TDG Design Criteria	**2**	**3**			
Taxiway Width	35’	50’	50’	60’ +	50’
Taxiway Shoulder Width	15’	20’[1]	N/A	N/A	N/A
Design Criteria	**Design Standard**		**Existing Dimension**		
			Taxiway C	**Taxiway D**	**Taxiway E**
ADG Design Criteria	**II**	**III**			
Taxiway Safety Area Width	79’	118’	118’	118’	118’
Taxiway Object Free Area Width	124’	171’	186’	186’	186’
Taxiway Centerline to:					
Parallel Taxiway/Taxilane Centerline	102’	144’	1,400’ +	1,200’ +	1,200’ +
Fixed or Movable Object	62’	85.5’	93’	93’	93’
TDG Design Criteria	**2**	**3**			
Taxiway Width	35’	50’	55’	55’	50’
Taxiway Shoulder Width	15’	20’[1]	N/A	N/A	N/A

Source: Mead & Hunt analysis using FAA AC 150/5300-13B, *Airport Design*.

Notes: [1] Paved taxiway shoulders are recommended, but not required for taxiways, taxilanes, and aprons accommodating ADG-III and below aircraft. Stabilized shoulders of turf are acceptable.

The taxiway design standards analysis indicates the existing conditions of Runway 17/35 meet or exceed the FAA design criteria. However, Taxiway B west of Runway 17/35 does not intersect the runway at a right-angle. FAA design recommendations are that taxiways should intersect runways at right angles unless specifically designed as high-speed exit taxiways to increase capacity of a runway. Therefore, Taxiway B west of Runway 17/35 should be redesigned to a right-angled taxiway when pavement condition warrants.

Taxiway design criteria for taxiways serving Runway 4/22 are based on the critical aircraft Cessna 172, which has an ADG of I and a TDG of 1A. **Table C-11** presents the design criteria, design standards, and existing conditions for taxiways serving Runway 4/22.

Table C-11: Taxiway Design Standards for Taxiways Serving Runway 4/22

Design Criteria	Design Standard	Existing Dimension		
		Taxiway B	Taxiway F	Taxiway F1
ADG Design Criteria	**I**			
Taxiway Safety Area Width	49’	49’	49’	49’
Taxiway Object Free Area Width	89’	89’	89’	89’
Taxiway Centerline to:				
Parallel Taxiway Centerline	70’	2,000’	2,450’	450’ +
Taxiway Centerline to Fixed or Movable Object	44.5’	45’	45’	45’
TDG Design Criteria	**1A**			
Taxiway Width	25’	50’	50’	50’
Taxiway Shoulder Width	10’[1]	N/A	N/A	N/A

Source: Mead & Hunt analysis using FAA AC 150/5300-13B, *Airport Design*.

Notes: [1] Paved taxiway shoulders not required for taxiways accommodating ADG-I aircraft. Stabilized shoulders of turf are acceptable.

While the existing dimensions of Runway 4/22 meet or exceed the FAA design criteria, Taxiway F1 is a non-standard taxiway. The design and location of Taxiway F1 nearly leads directly from the Hangar 1 Ramp to Runway 4/22. To reduce the probability of inadvertent runway incursions, proper taxiway design requires a turn be executed by the pilot when leaving an apron before entering the runway system. The suggested design requires two 90-degree turns instead of one approximate 30-degree turn, as the current design provides. SWO staff report that Taxiways A and F, near the intersection with Runway 4/22 have been known to cause pilot confusion. However, this confusion is often remedied with Airport Traffic Control Tower (ATCT) instructions.

Exit Taxiways

Optimally located exit taxiways minimize runway occupancy times and allow the airfield to be used more efficiently. Figure 4-17 in AC 150/5300-13B provides the cumulative percentages of aircraft able to exit runways at specific exit taxiway locations, given in 1,000-foot increments. Percentages for both right-angled and acute-angled taxiway configurations are included for each AAC.

Runway 17/35 Exit Taxiways

Table C-12 presents the location of current exit taxiways serving Runway 17/35 and the approximate percentages of landing aircraft types that can exit the runway in a safe and efficient manner.

Table C-12: Runway 17/35 Exit Taxiway Analysis

Runway / Taxiway	Distance From Runway Threshold	Percentage of Landing Aircraft Exit Probability		
		AAC A	AAC B	AAC C
Runway End 17				
Taxiway E	1,425’	3	1	0
Taxiway D	2,625’	71	18	0
Taxiway C	4,025’	100	76	2
Taxiway B	6,015’	100	100	88
Taxiway A	7,375’	100	100	100
Runway End 35				
Taxiway B	1,385’	2	0	0
Taxiway C	3,375’	96	50	0
Taxiway D	4,775’	100	95	23
Taxiway E	5,975’	100	100	88
Taxiway A	7,375’	100	100	100

Source: Mead & Hunt analysis using FAA AC 150/5300-13B, *Airport Design*.

The taxiways of Runway 17/35 appear suitably spaced to accommodate all aircraft sizes from either direction.

Runway 4/22 Exit Taxiways

Runway 4/22 does not have a high-speed exit taxiway but Taxiways A and F1 are obtuse-angled taxiways for aircraft landing to Runway End 22. For aircraft landing to Runway End 4 they are acute-angled but do not meet the requirements for high-speed exit taxiways. Therefore, they will be analyzed as right-angled taxiways. **Table C-13** presents the location of existing exit taxiways serving Runway 4/22 and the approximate percentages of landing aircraft types that can exit the runway in a safe and efficient manner.

Table C-13: Runway 4/22 Exit Taxiway Analysis

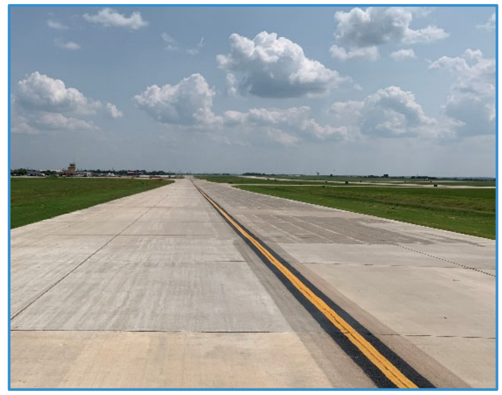
Runway / Taxiway	Distance From Runway Threshold	Percentage of Landing Aircraft Exit Probability		
		AAC A	AAC B	AAC C
Runway End 4				
Taxiway A	2,140’	33	5	0
Taxiway F1	2,600’	81	27	0
Taxiway F	4,975’	100	97	37
Runway End 22				
Taxiway F1*	2,400’	71	20	0
Taxiway A*	2,875’	88	33	0
Taxiway B	4,975’	100	97	37

Source: Mead & Hunt analysis using FAA AC 150/5300-13B, *Airport Design*.
Note: * Acute-angled taxiways.

Most of the taxiways serving Runway 4/22 are sufficiently placed to ensure adequate exits for small aircraft. Taxiway F1, with its non-standard design, hinders the ability of aircraft to use F1 from both directions. Aircraft landing to the northeast on Runway End 4 are met with a sharp turn of approximately 150 degrees at Taxiway F1, which limits the ability of aircraft to exit on F1 from that direction.

Taxiway/Taxilane System Conclusion

The existing taxiway/taxilane system in place at SWO meets most FAA standards. However, the non-standard design and location of Taxiway F1 nearly connects Runway 4/22 directly to the Hangar 1 Ramp. Taxiway F1's angle also introduces potential issues for aircraft exiting Runway 4/22 when landing to the northeast. As pavement conditions warrant, a redesign of Taxiways B (west of Runway 17/35) and F1 to right-angled taxiways is recommended. This will alleviate the non-right-angled taxiway intersections and the direct access from the Hangar 1 Ramp to the runway environment.



AIRFIELD CAPACITY ANALYSIS

The capacity of an airfield is primarily a function of the major aircraft operating surfaces that compose the facility and the configuration of those surfaces (runways and taxiways). However, it is also related to and considered in conjunction with environmental conditions, wind coverage, airspace utilization, and the availability and type of navigational aids. Capacity refers to the number of aircraft operations that a facility can accommodate either on an hourly or yearly basis. It does not refer to the size or weight of aircraft.

The evaluation method used to determine airfield capacity comes from AC 150/5060-5, *Airport Capacity and Delay*. From this methodology, airfield capacity for long-range planning is defined in the following terms:

- **Hourly Capacity of Runways:** The maximum number of aircraft that can be accommodated under conditions of continuous demand during a one-hour period during both VFR and IFR conditions.
- **Annual Service Volume (ASV):** A reasonable estimate of an airport's annual capacity (i.e., level of annual aircraft operations that will result in an average annual aircraft delay of approximately one to four minutes).

Airfield Capacity Factors

Airfield capacity for long-range planning is a function of several factors, including the layout of the airfield, local environmental conditions, specific characteristics of local aviation demand, and air traffic control requirements.

Airfield Layout and Runway Use

The arrangement and interaction of airfield components (i.e., runways, taxiways, and ramp entrances) refers to the layout or "design" of the airfield. Runway use is primarily defined by the orientation of the active runways with prevailing winds, the available IAP capabilities, and the distribution and frequency of aircraft operations on the airfield facilities. SWO operates with a two intersecting runway configuration (Runways 17/35 and 4/22) that are supported by a system of parallel and connecting taxiways. Intersecting runways do not maximize overall capacity as they cannot be used simultaneously because when aircraft are using one runway, aircraft on the other runway must wait.

As presented in the previous chapter, SWO ATCT staff indicate that Runway 17/35 is used approximately 80 percent of the time, with Runway 17 used approximately 60 percent and Runway 35 used approximately 40 percent. Runway 4/22 is estimated to be used approximately 20 percent of the time, with Runway 4 utilized an estimated 60 percent of the time and Runway 22 used approximately 40 percent.

Meteorological Conditions

Low cloud ceilings and reduced visibility typically reduce capacity. Three categories of ceiling and visibility minimums are considered. Visual Flight Rules (VFR) conditions occur when the cloud ceiling is greater than or equal to 1,000 feet above ground level (AGL), and visibility is greater than or equal to three statute miles. National Oceanic and Atmospheric Administration (NOAA) data shows that these conditions occur 78 percent of the time at SWO. Instrument Flight Rules (IFR) conditions occur when the cloud ceiling is less than 1,000 feet AGL, or visibility is less than three statute miles. These conditions occur 22 percent of the time at SWO. Poor visibility and ceiling conditions exist whenever the cloud ceiling is less than 200 feet AGL, or visibility is less than 1/2 statute mile. These conditions are lower than the ILS minimums, effectively closing SWO. These conditions occur less than 1 percent of the time at SWO.

Aircraft Mix

Aircraft mix is the relative percentage of aircraft operations that have a MTOW over 12,500 pounds. The aircraft mix index is determined by the equation (C+3D), where C is the percent of aircraft with MTWO over 12,500 pounds but under 300,000 pounds, and D represents the percent of aircraft over 300,000 pounds MTOW. **Table C-14** outlines the data used to determine the aircraft mix index.

Percent Arrivals

Runway capacity is significantly influenced by the percentage of all operations that are arrivals. Because aircraft on final approach are travelling at a reduced speed and are typically given absolute priority over departures, higher percentages of arrivals during peak periods of operations will reduce the ASV. The operations mix at SWO reflects a general balance of arrivals to departures. Therefore, for the capacity calculations arrivals equal departures during the peak period.

Table C-14: Aircraft Fleet Mix, 2020-2040

Year	VFR Conditions			IFR Conditions		
	Class A & B	Class C	Class D	Class A & B	Class C	Class D
2020	97%	3%	0%	95%	5%	0%
2025	97%	3%	0%	95%	5%	0%
2030	97%	3%	0%	95%	5%	0%
2035	97%	3%	0%	95%	5%	0%
2040	97%	3%	0%	95%	5%	0%

Source: Existing percentages Future percentages estimated by Mead & Hunt.

Notes: Class A = Small Single Engine, < 12,500 pounds. Class B = Small Twin-Engine, < 12,500 pounds.
Class C = 12,500 – 300,000 pounds. Class D = > 300,000 pounds.

Touch-and-Go Operations

As presented in the previous chapter, touch-and-go operations represent 54 percent total annual operations being conducted at SWO. It is anticipated that by 2040 the overall percentage of touch-and-go activity will decrease slightly to 53 percent.

Exit Taxiways

The amount, spacing, and design of exit taxiways influence the length of time aircraft occupy runways by providing aircraft the ability to exit runways as quickly and safely as possible. SWO generally has an adequate exit system in place to minimize runway occupancy times and maximize airfield capacity. The lone exceptions would be Taxiways A and F1 since they are obtuse angled for aircraft landing to Runway End 4. Aircraft landing to the northeast would have to be travelling at a slower speed to make these exits than aircraft landing to the southwest. While these taxiways have additional pavement design to accommodate exiting aircraft landing to the northeast, some aircraft using Runway End 4 might not have the ability to slow down in sufficient time to make the exits and would have to travel to the end of the runway before exiting at Taxiway F. Because Taxiway A is the parallel taxiway service the primary runway, it will remain. However, a reconstruction of Taxiway F1 to a right-angled taxiway would provide a slight benefit for aircraft with faster landing speeds using Runway End 4. Additionally, as presented previously, a redesign that alleviates the nearly direct access from the Hangar 1 Ramp to the Runway 4/22 environment would reduce the probability of runway incursions.

Air Traffic Control Rules

The FAA specifies aircraft separation criteria and operational procedures for aircraft in the vicinity of airports, contingent upon aircraft size, availability of radar, sequencing of operations, and noise abatement procedures that may be in effect at an airport. The impact of air traffic control on airfield capacity is most influenced by aircraft separation requirements dictated by aircraft mix. Presently, there are no special air traffic control rules in effect at SWO that significantly affect airfield capacity.

Airfield Capacity Analysis

As previously indicated in this section, the determination of ASV and hour capacity for long-range planning purposes uses the methodology described in AC 150/5060-5. Several assumptions are incorporated in these capacity calculations, which are:

- Arrivals equal departures
- Percentage of touch-and-go operations is between zero and 50 percent
- There is a full-length parallel taxiway with ample exits and no taxiway crossing problems
- There are no airspace limitations
- There is at least one runway equipped with and ILS and the necessary air traffic control facilities to carry out operations in a radar environment
- IFR weather conditions occur roughly 10 percent of the time
- Approximately 80 percent of the time the airport is operated with the runway use configuration that produces the greatest hourly capacity.

It is recognized that SWO does not conform to all the assumptions listed above, mainly that the percentage of touch-and-go operations exceeds 50 percent.

Applying the information generated from the preceding analyses, guidelines, and assumptions, SWO's ASV is calculated at approximately 230,000 annual aircraft operations, with a VFR hourly capacity of 98 operations and an IFR hourly capacity of 59 operations. As presented in **Table C-15**, SWO's current operations are at approximately 27.2 percent of ASV and will be at 42.2 percent of ASV in 2040.

Table C-15: Annual Service Volume and Demand Capacity Analysis, 2020-2040

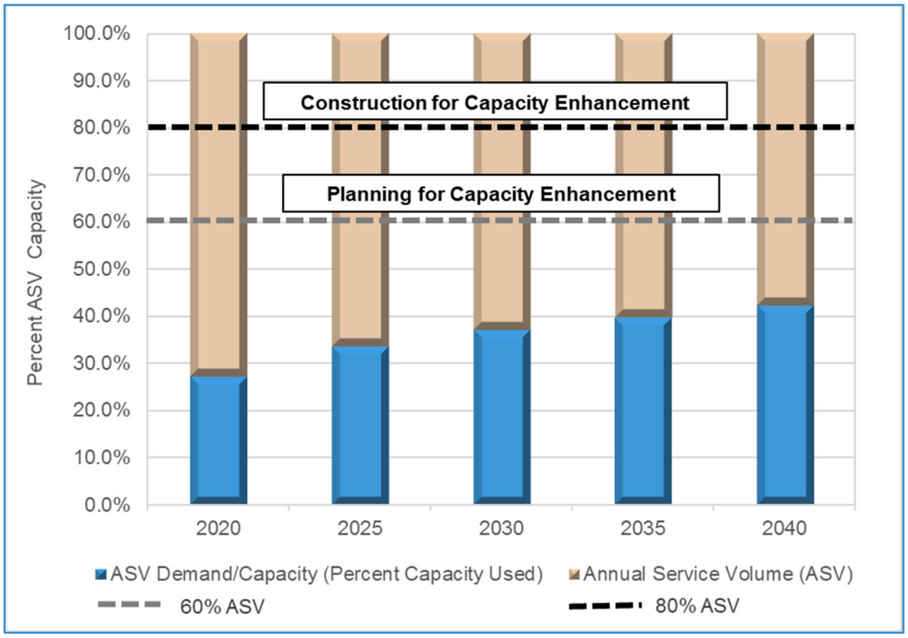
ASV Capacity Components	2020	2025	2030	2035	2040
Annual Aircraft Operations	62,643	77,354	85,234	91,200	97,044
Airport Operational Peaking					
Peak Month Operations	8,077	10,056	11,080	11,856	12,616
Average Day of Peak Month Operations	269	335	369	395	421
Peak Hour Operations	30	37	41	44	46
Hourly Capacity VFR/IFR	98/59	98/59	98/59	98/59	98/59
ASV	230,000	230,000	230,000	230,000	230,000
ASV Demand/Capacity (Percent Capacity Used)	**27.2%**	**33.6%**	**37.1%**	**39.7%**	**42.2%**

Source: Mead & Hunt analysis using FAA AC 150/5060-5.

Notes: SWO critical aircraft, [E] – Existing, [F] – Future.

Figure C-2 compares the calculated ASV to the existing and projected aircraft operations expressed as a percentage of ASV. FAA guidelines indicates that when 60 percent to ASV is reached, an airport should begin planning ways to increase capacity, and when 80 percent of ASV is reached then construction of facilities needed to increase capacity should be initiated. The ASV analysis does not indicate areas of systemic airfield capacity challenges occurring either on an hourly basis (both VFR and IFR) or an annual basis.

Figure C-2: Annual Service Volume and Demand Comparison



Source: Mead & Hunt analysis.

Airfield Capacity Conclusion

The existing airfield configuration provides adequate capacity for the operations forecast through 2040. Future operations are not expected to exceed the 60 percent threshold to trigger planning for airfield capacity improvements.

LANDSIDE FACILITY REQUIREMENTS

Landside facilities are those facilities that support the airside facilities but are not actually a part of the aircraft operating surfaces. These consist of such elements as the terminal building, aircraft parking aprons, corporate and GA hangars, Fixed Base Operator (FBO) facilities, Aircraft Rescue and Fire Fighting (ARFF) facilities, fuel storage and dispensing systems, aeronautical and non-aeronautical development, utilities, perimeter security, and access roads. Following an analysis of these existing facilities, current deficiencies can be noted in accommodating both existing and future needs.

Terminal Building Requirements

The terminal building is the face of SWO to the community and the front door for many visitors to Stillwater. Quality amenities and adequate space encourage visitors and the local community to use SWO, add value to the passenger experience, and improve the perception of SWO.

The objective of noting facility requirements for the terminal building is to identify the type, quality, and quantity of the facilities that are required for the terminal to operate safely and efficiently through the planning period. While some of the recommendations made for SWO intend to address specific shortfalls, others are to improve general performance. This section largely analyzes the future needs based on forecasted activity levels of a new, fully reconstructed terminal building, rather than requirements for the existing terminal building.

Methodology

Given the size of SWO and the forecasted passenger levels throughout the planning period, terminal building components are calculated using peak hour enplanements. Enplanement figures were taken from **Table B-27** of the previous chapter and reprised in **Table C-16**, which have been multiplied by industry standards for space per passenger to yield the total space requirements for the terminal building. Component performance was measured by processing and wait times, with the latter representing the amount of time passengers wait at a ticket counter agent position and in the queue. These elements are then translated into component level of service.

Table C-16: Peak Hour Enplanements, Deplanements and Total Passengers 2020-2040

Peak Period Activity	2020	2025	2030	2035	2040
Peak Hour Enplanements	48	44	51	58	66
Peak Hour Deplanements	45	43	49	56	64
Total Peak Hour Passengers	**93**	**87**	**100**	**114**	**130**

Source: Mead & Hunt projections.

Future component capacity requirements are based on forecasted demand. When demand begins to exceed capacity, this represents a point at which the system will become stressed and may possibly exceed available space at individual components and within the overall space. Such a breakdown in performance can result in increased passenger processing and wait times, queues, congestion, interference with adequate circulation, and diminished passenger level of service. This is normally evident at peak seasonal travel periods, with a potential decline in level of service occurring for a limited period prior to flight departure. In general, this is expected and acceptable. However, once the decline extends beyond a certain threshold of time and/or space, additional capacity must be provided.

For SWO, calculating the capacity of terminal components has an allowance for university athletic teams travelling on non-scheduled charter flights. These intermittent flights increase the throughput capacity on selected terminal components. Currently, security screening of the chartered passengers is conducted by outside security contractors using temporary metal detectors and tables in the lobby near the Stillwater Flight Center office. Screened passengers exit the terminal building through doors with direct apron access and board the chartered aircraft via apron loading. Accommodating non-scheduled chartered passengers within the future terminal building can be accomplished by one of two means:

1. Sharing scheduled commercial service programmed facilities.
2. Increasing the terminal size to account for desired level of service and potential overlap of operations.

This analysis uses the first scenario, in which scheduled commercial service dictates the component evaluations which are available for university athletic teams' chartered aircraft with seating capacity of approximately 150 seats.

For the purposes of this study, the following references are used in determining the terminal building requirements:

- FAA Advisory Circular 150/5360-13A, *Airport Terminal Planning*
- 10th and 11th Editions of the IATA *Airport Development Reference Manual* (ADRM)[1]
- ACRP Report 25*, Airport Passenger Terminal Planning and Design, Volumes 1 & 2: Guidebook and Analysis Worksheets*

Analysis

Terminal Gates and Aircraft Parking Positions

The new terminal building will require one gate and one aircraft parking position based on forecasted enplanements. Aircraft apron area is listed under **Table C-17**. The table includes aircraft to be used at SWO, which support enplanements over the planning period. Envoy Airlines currently operates twice daily flights using the 50-seat ERJ 145 aircraft at SWO. As stated in the previous chapter, 76-seat ERJ 175 aircraft are expected to completely replace the ERJ 145s nationwide by 2031, and possibly sooner at SWO. Additionally, Boeing 737-800 aircraft are representative of the narrow body charters used by university athletic teams. It is also the largest aircraft on SWO's apron. The total commercial service apron area required for simultaneous occupancy by one ERJ 175 and one Boeing 737-800 is 43,545.

Table C-17: Terminal Aircraft Apron Area by Aircraft Type with Minimum Setback from Building

Aircraft Capacity			Gate Requirements and Total Area				
			Aircraft Specs		Aircraft Apron Area		
ADG	Terminal Design Aircraft	Design Aircraft Seats	Wing Span	Length	Aircraft Separation	Setback Nose to Building	Gate Area (sq ft)
II	ERJ 145	50	65.75'	87.83'	25'	35'	11,638
III	ERJ 175	76	93.92'	103.92'	25'	35'	20,793
IV	B 737-800	150	117.42'	129.50'	25'	35'	22,752'

Source: Mead & Hunt analysis.

SWO has paved a large area of apron, including within the area designated previously as the preferred future terminal building site. SWO has the option of striping only the area of apron that will serve the scheduled and non-schedule air carrier aircraft operated during the planning period. This will allow the remaining apron to be used for GA use.

[1] *Airport Development Reference Manual, 10th Edition, October 2016, and 11th Edition, March 2020, The International Air Transport Association.*

Main Entrance Hall

There are three separate areas of public circulation: the departures, entrance, and arrivals halls. The depth of this corridor was determined by the ticket hall, which begins at the face of the ticket counters. This provides passenger processing depth and bypass circulation of 8 feet (i.e., the 3 feet a passenger occupies at the counter plus a 5-foot clear walkway for passengers), passenger queue of 10 feet, corridor circulation of 12 feet, and passenger seating of 5 feet, for a total width requirement of 35 feet. The length of the corridor is dependent upon the terminal layout plan and orientation of the security checkpoint. The ticketing and claim hall circulation areas are listed in each component's area summary. The main entrance hall is calculated at 40 feet in length by 35 feet in width, for a total area of 1,400 square feet.

Passenger Ticketing and Check-In

Calculating airline ticketing and queueing areas to support departing passengers is dependent upon when passengers arrive at the terminal. The normal departing passenger arrivals curve (i.e., the time passengers arrive at the terminal prior to their flight) typically shows most passengers arrive between 100 to 40 minutes prior to departure. This period represents the peak hour. However, a shorter period of one-half hour and a smaller percentage of the total peak, 49 percent, was used for this passenger demand analysis because it tends to represent a peak period within the peak hour. This places greater demand on the component thus requiring greater capacity. It is akin to adding a more accurate surge factor.

The ticketing and check-in area calculations include both kiosks and counter positions, with the latter providing full services, boarding pass, baggage tags, and baggage check. Passengers may print boarding passes prior to arrival but may still use either kiosks or counters to obtain baggage tags. All passengers checking bags will contact the ticket counters. **Table C-18** details the airline ticketing area requirements.

Table C-18: Airline Ticketing and Check-In Assumptions and Requirements

Passenger Ticketing and Check-In Demand Profile	2020	2025	2030	2035	2040
Design Hour Departing Passengers	48	44	51	58	66
Percent of Passengers in Peak 30 Minute Period	49%	49%	49%	49%	49%
Percent of Passengers Using Ticketing	75%	75%	75%	75%	75%
Peak 30-Minute Originating Passengers	18	16	19	21	24
Processing Time Per Passenger (Average)	2.5	2.5	2.5	2.5	2.5
Service Level Maximum Wait Time	10	10	10	10	10
Queue Results					
Number of Staffed Service Positions Required	2	2	2	2	2
Average Queue Wait Time	1	1	1	1.5	3
Maximum Queue Wait Time	2	1	2	3.5	6
Maximum Number of Passengers Waiting in Queue	**1**	**1**	**2**	**3**	**5**

Source: Mead & Hunt analysis.

Ticket counter frontage, which is the amount of linear footage each counter provides, is important in managing passenger queues. Airports may opt to increase counter length to provide more area for passenger queues, which can reduce the depth of the ticket hall. It also allows for additional staff during anticipated peak passenger demand times (e.g., seasonal holidays) providing a greater level of service and capacity for processing customers to meet scheduled departure times. Adequate counter length has been included in the program to meet the potential requirements for a second airline or second peak-hour flight int eh future. **Table C-19** shows the ticket hall requirements.

Table C-19: Ticket Hall Requirements

Terminal Ticket Hall Requirements	Measurement
Ticket Counter and Concourse Length (ft)	24
Passenger Check-In, Circulation, Queue Seating Area (sq ft)	840
Seating Area (sq ft)	120
Total Terminal Ticket Hall Area (sq ft)	**960**

Source: Mead & Hunt analysis.

Airline Ticket Offices (ATOs) are areas consisting of airline ticketing, check-in, baggage check (i.e., the area behind the ticket counters), and the private offices and operations areas that support the airlines' business. These areas typically include a manager and supervisors' office, an agent check-in and check-out area, a break room, a locker room, office equipment, and supplies storage. The operations area includes workstations for supervisors and managers (e.g., aircraft load and balance figures/statistics), as well as equipment storage, radio chargers, and baggage tugs and carts. Airlines will need at least one parking space for a company SUV at the apron area adjacent to their operations space. **Table C-20** details the calculations for ATO space needs. A detailed breakdown of the proposed ATO and ground operations areas is included in **Appendix Five**

Table C-20: Airline Ticket Offices and Ground Operations Area

Airline Ticket Offices and Ground Operations Requirements	Area (sq ft)
Airline Ticket Offices	568
Airline Ground Operations	556
Sub-Total	**1,124**
Circulation (10%)	112
Subtotal ATO and Ground Operations	**1,236**
GSE Equipment Storage	800
Total ATO and Ground Operations Space	**2,036**
Total Area for Two ATO and Ground Operations Spaces	**4,072**

Source: Mead & Hunt analysis.

Checked Baggage Inspection Screening

The Transportation Security Administration (TSA) operates checked baggage inspection screening manually, using Explosive Trace Detection (ETD) devices in the process. This is not anticipated to change during the planning period. **Table C-21** lists the number of ETD devices required during the 20-year planning period.

Table C-21: Checked Baggage Inspection Screening Assumptions & Area Requirements

Baggage Screening Demand Profile	2020	2025	2030	2035	2040
Peak Hour Passengers Checking In	48	44	51	58	66
Percent of Passengers Checking Bags	65%	65%	65%	65%	65%
Average Number of Bags Per Passenger	1	1	1	1	1
Number of Bags to Process in Peak Hour	31	28	33	38	43
Percent of Over & Odd-Size Bags	2%	2%	2%	2%	2%
Total Number of Bags to Process	31	29	33	38	43
Process Rates Per Hour ETD	24	24	24	24	24
Number of ETD Required	2	2	2	2	2
Total Area Required (sq ft)	**300**	**300**	**300**	**300**	**300**

Source: Mead & Hunt analysis.

Airline Outbound Baggage Make-Up Room

The values shown in **Table C-22** were calculated for scheduled flights in each period based on its forecasted critical aircraft. Area calculations use a runout conveyor from the TSA's screening room into the make-up area, usually running along the back wall of the space. Baggage carts are manually set perpendicular to the conveyor so they can be pulled directly out of the make-up room by the baggage tug driver. The loading area is protected and closed after the flights have departed. The make-up room has been programmed for a single ERJ 175 aircraft, with space allocated for loading two carts per flight. This allows for seasonal increases in checked baggage. If needed, university athletic team charter flights can use this facility.

Table C-22: Airline Outbound Baggage Make-Up Room Area

Baggage Make-Up Demand Profile	2020	2025	2030	2035	2040
Narrow-Body Equivalent Aircraft	0.7	0.7	0.7	0.7	0.7
Scheduled Departures Per Gate in 2 – 3 Hour Period	1	1	1	1	1
Staged Carts per Equivalent Aircraft	1	1	1	1	1
Area Required per Cart (sq ft)	200	200	200	200	200
Make-Up Area Required (sq ft)	300	300	300	300	300
Conveyor and Circulation (sq ft)	250	250	250	250	250
Total Make-Up Area (sq ft)	**950**	**950**	**950**	**950**	**950**

Source: Mead & Hunt analysis.

Passenger Security Screening Checkpoint

The TSA has one security screening checkpoint in the existing terminal building. Given that passengers typically arrive at the terminal over a period greater than one hour, a single checkpoint will remain sufficient to manage demand and process the number of enplanements on scheduled commercial flights through 2040. TSA's innovations in security screening have been installed at major airports, the most recent with an announcement that Analog Computed Tomography (CT) scanning devices are being installed throughout the country. SWO's existing screening device will likely be replaced when a new terminal is built; TSA's new checkpoint layout standards were released in December 2021, thereby affecting all new installations. The Analog CT scanner or another similar device will be installed at SWO in the future as these are representative of the TSA's technology program for security screening checkpoints.

The values in **Table C-23** list results for the anticipated departing passenger demand. The null, or zero, maximum wait time shown in the chart is considered a very good level of service during the peak hour.

Table C-23: TSA Security Screening Checkpoint Requirements and Area

Security Screening Demand Profile	2020	2025	2030	2035	2040
Design Hour Departing Passengers	48	44	51	58	66
Number of Passengers in Peak 30-Minute Period	25	24	29	34	39
Screening Throughput Rate per Hour	150	150	150	150	150
Passengers Processed Per Minute Per Lane	2.5	2.5	2.5	2.5	2.5
Maximum Target Wait Time in Queue	10	10	10	10	10
Minimum Required Number of Screening Lanes	1	1	1	1	2
Maximum Wait Time in Queue	-	-	-	-	-
Checkpoint Space Requirements (sq ft)	**2,100**	**2,100**	**2,100**	**2,100**	**2,100**

Source: Mead & Hunt analysis.

TSA's field office operations space requirements are listed in **Table C-24**.

Table C-24: TSA Field Office Area

TSA Field Office Requirements	2020	2025	2030	2035	2040
Transportation Security Manager-on-Duty	120	120	120	120	120
Break/Training Room	150	150	150	150	150
Training Storage	100	100	100	100	100
IT Room	30	30	30	30	30
Total TSA Field Office (sq ft)	**400**	**400**	**400**	**400**	**400**

Source: Mead & Hunt analysis.

Passenger Departures Lounge

Passenger departures lounge space requirements were initially calculated to serve ERJ 145 aircraft. Upgauging the aircraft to the next higher seat capacity aircraft (i.e., ERJ 175) would have a limited effect on overall passenger level of service in this area due to the area per passenger provided in the calculations. However, it would be prudent to plan and program the terminal building with the larger seat capacity of the ERJ 175 from the beginning, which is included in the following space calculations. Various lounge seating types and arrangements would be possible within this space. Concessions amenities would be provided for this area, increasing the total number of seats and space. A service animal relief area will also be provided adjacent to this space. Passenger departures lounge seating area and ancillary space requirements are presented in **Table C-25**.

Table C-25: Passenger Departures Lounge

Passenger Departures Lounge Demand Profile	2020	2025	2030	2035	2040
Peak Hour Departing Passengers	48	44	51	58	66
Departures Lounge Seating Area (sq ft)	1,296	1,245	1,380	1,635	1,775
Gate Podium Width / Depth	4 / 8	4 / 8	4 / 8	4 / 8	4 / 8
Area per Podium Position (sq ft)	32	32	32	32	32
Number of Podium Positions	1	1	1	1	1
Total Podium and Queue Area (sq ft)[1]	100	100	100	100	100
Boarding Corridor Width / Lounge Depth	6 / 25	6 / 25	6 / 25	6 / 25	6 / 25
Total Boarding Corridor (sq ft)	150	150	150	150	150
Total Departures Lounge Area (sq ft)	**1,160**	**1,545**	**1,680**	**1,885**	**2,025**
Total Area for Two Departure Lounges (sq ft)	**2,320**	**3,090**	**3,610**	**3,770**	**4,050**

Source: Mead & Hunt analysis.

Note: [1] Assumes a 25-foot lounge depth.

Concessions

Proposed concessions for SWO are comprised of a restaurant serving the public pre-secure area, so that it can become viable through airport business patronage. A small news/gift store located within the public concourse that has proximity and visibility to both departing and arriving passengers should also be provided. A news/gift store and cafe that includes both fresh bakery as well as pre-prepared packaged sandwiches, and other refrigerated foods, would best serve passengers in the post-security area of the terminal building. Small airports have successfully managed a dual operation that allows the larger restaurant to serve both pre-secure and post-secure spaces; this would also be the recommendation for food and beverage service at SWO. Terminal concessions requirements are shown in **Table C-26**.

Table C-26: Terminal Concessions

Terminal Concessions Requirements	Area (sq ft)
Public Pre-Secure Space	
Restaurant [1]	1,500
News and Gifts	150
Passenger Post-Security Space	
News/Gifts and Cafe	225
Seating Area	150
Total Concessions Area (sq ft)	**2,025**

Source: Mead & Hunt analysis.

Note: [1] Restaurant space includes kitchen and refrigerator storage.

Secure Concourse Circulation

Secure concourse circulation is determined broadly by calculating the number of equivalent aircraft in the flight schedule.[2] One aircraft is currently operated at SWO, an ERJ 145, which counts as one equivalent aircraft. Using an aircraft wingtip separation of 25 feet and aircraft wingspan of 79 feet for ADG II, concourse

[2] Using ACRP Report 25, Equivalent Aircraft value equals .70 for an Embraer 145 aircraft and is rounded up in the worksheets. An EJR 175 aircraft also counts as on Equivalent Aircraft.

length circulation is equal to 104 feet multiplied by the corridor width of 15 feet to equal a total of 1,560 square feet of secure concourse circulation area.

As stated previously, accommodating the ERJ 175 aircraft in the initial terminal building planning and programming is prudent. With a larger wingspan than the ERJ 145, ERJ 175 increases the ADG from II to III. Under the circumstances, using the smaller 94-foot wingspan of the ERJ 175 rather than the full 118-foot width of the ADG III category would be more appropriate for determining the overall width of the secure circulation space.

Using a premise of two parking positions would translate into 213 total feet of secure concourse length and corresponding departure lounge; however, this length would be considered greater than necessary during the early timeframe of the planning period. Depending on terminal arrangement, this building length might be required due to activities on the non-secure public side of the building. A balance must be struck between the departures lounge efficiency on the secure side of the terminal and the activities on the non-secure public side. Applying a depth of 15 feet provides the total square footage of the secure concourse circulation needs.

A lounge depth of 25 feet is considered the minimum for passenger queueing at the gate during boarding to keep the circulation corridor from becoming congested. Other uses can fill the space between the lounges but overflow of passengers from one lounge to the other might be compromised. A reduced initial secure concourse length may be appropriate, with an understanding that expansion of the concourse beyond the planning period might be necessary to meet requirements. This is left to the design team's discretion based upon location, adjacency, and layout of the components.

Restrooms

Secure and non-secure restroom programming figures fall below the threshold of 3.0 equivalent aircraft (EQA) requirement noted in the reference guide ACRP Report 130: *Guidebook for Airport Terminal Restroom Planning and Design*. Using this guidance, a minimum of six fixtures are required per men's restroom. Men's fixtures serve as the basis for calculating women's restroom fixture requirements with parity set at a 1.25 factor, or a 56 percent to 44 percent ratio of women to men. Women's restrooms are therefore calculated to have eight fixtures. Since secure restrooms are calculated using arriving passengers as a basis for planning, the figures are also appropriate for serving a narrow body charter aircraft at SWO.

Non-secure restrooms are typically smaller than secure restrooms, as the number of passengers and visitors in the departures or arrivals areas will see stable usership over time instead of a spike. This is compared to deplaning passengers, who will use a restroom during a very short period immediately following a flight. For SWO, four fixtures for men and five for women is appropriate. This provides one accessible and one standard water closet and two urinals for the men's restroom, and one accessible and four standard water closets for the women's restroom. The latter is equivalent to one fixture per 30 passengers and visitors for a combined arrival and departure flight. The restroom area is calculated as fixtures multiplied by 135 square feet per fixture. Restroom requirements are shown in **Table C-27**.

Table C-27: Restroom Fixtures and Area

Restroom Requirements	Fixtures	Area (sq ft)
Public Pre-Secure Space		
Men's Restroom	4	540
Women's Restroom	5	675
Family Restroom	1	120
Mother's Room [2]	-	100
Janitor	-	80
Total Fixtures and Area	**10**	**1,435**
Passenger Post-Security Space		
Men's Restroom	5	675
Women's Restroom	6	810
Family Restroom	1	120
Mother's Room	-	100
Janitor	-	100
Total Fixtures and Area	**12**	**1,705**
Grand Total Fixtures and Area	**22**	**3,140**

Source: Mead & Hunt analysis.

Notes: [1] Restroom space is calculated using 135 square feet per fixture, which accounts for the fixture, lavatory, circulation, and plumbing access.

[2] Mother's room is included with the restroom program. However, it is preferable for this function to be located away from the restroom block to a quieter area of the terminal.

One family restroom is located inside both the secure and non-secure areas as part of the restroom block. A mother's room should be planned and designed as a part of the terminal public and secure passenger space. The location should be convenient to both arrivals and departures halls but should remain separate from the restroom area. A service animal relief area (SARA) of at least 150 square feet is also required on the secure side of the terminal.

Baggage Claim

Baggage claim device display length is calculated using a peak 20-minute period for arriving passengers. At SWO, all passengers will arrive at the claim hall within 20 minutes of disembarking their flight. The area of the claim hall is determined by the device length, the number of passengers claiming bags, and industry standards for claim hall space. **Table C-28** lists these factors and results of the analysis.

The baggage claim area consists of the claim device, passenger queueing area around the device, and the circulation area. A baggage services office is likely not required initially, since the airline will keep unclaimed baggage at their ticket office.

Table C-28: Baggage Claim Assumptions & Device Length

Baggage Claim Demand Profile	2020	2025	2030	2035	2040
Design Hour Arriving Passengers	45	43	49	56	64
Passengers Arriving in Peak 20-Minute Period	45	43	49	56	64
Percent of Passengers Checking Bags	65%	65%	65%	65%	65%
Passengers Checking Bags	29	28	32	37	42
Average Number of Bags Per Passenger	1	1	1	1	1
Number of Bags to Process in Peak Period	29	28	32	37	42
Average Passenger Party Size	1.2	1.2	1.2	1.2	1.2
Number of Passenger Parties	24	23	27	31	35
Percent of Additional Visitors at Claim	10%	10%	10%	10%	10%
Total People at Claim Device	27	25	29	34	39
Claim Device Display Frontage per Person	1.5	1.5	1.5	1.5	1.5
Total Length of Baggage Claim Device Display (ft)	**40**	**38**	**44**	**51**	**58**

Source: Mead & Hunt analysis.

With the option for allowing university athletic teams use of the baggage claim device, additional length would have the additional benefit of reducing passenger congestion during normal use. An alternative is to provide a single run-out belt along the length of the outside wall of the baggage claim area. This would allow the larger bags for team members' gear to be delivered in an orderly manner. Passengers can queue in the adjacent baggage claiming area, and smaller bags can still be delivered to the claim device. The run-out belt could serve scheduled commercial service passengers travelling with odd or oversize bags

Providing a baggage claim device with 75 linear feet of display frontage will provide additional length to account for seasonal travel. **Table C-29** details the baggage claim area requirements.

Table C-29: Baggage Claim Area

Baggage Claim Demand Profile	2020	2025	2030	2035	2040
Length of Baggage Claim Device Display	40	38	44	51	58
Passenger Claim Area	750	570	660	765	870
Circulation Factor	1.25	1.25	1.25	1.25	1.25
Passenger Area	695	712	825	956	1,088
Claim Device Area	282	262	322	392	462
Total Claim Area (sq ft)	**977**	**974**	**1,147**	**1,348**	**1,550**
Claim Hall Circulation (sq ft)	**1,750**	**1,750**	**1,750**	**1,750**	**1,750**

Source: Mead & Hunt analysis.

Rental Car Agencies

Enterprise currently serves SWO. Space for their counter and operations offices will be provided along with space for an additional car rental company, which will be provided when the need occurs. The standard counter and operations office is 150 square feet with an allowance for passenger queueing set at eight feet from the counter. This equates to a total of 230 square feet for each rental car company.

Building Support and Envelope Space

Building systems, chases, and interior and exterior wall structures represent approximately 15 percent of the total area of the terminal building. The terminal space summary is detailed in **Table C-30**.

Table C-30: Terminal Space Summary

Terminal Space Summary by Component (sq ft)	2020	2025	2030	2035	2040
Main Entrance Hall	1,400	1,400	1,400	1,400	1,400
Terminal Ticket Hall	960	960	960	960	960
Airline Ticket Office & Ground Operations	4,072	4,072	4,072	4,072	4,072
Checked Baggage Inspection Screening	300	300	300	300	300
Airline Outbound Baggage Make-Up	950	950	950	950	950
Passenger Security Screening Checkpoint & Exit Lane	2,100	2,100	2,100	2,100	2,100
Secure Concourse Exit Lane [1]	520	520	520	520	520
TSA Field Office	400	400	400	400	400
Secure Concourse Circulation	3,195	3,195	3,195	3,195	3,195
Passenger Departures Lounge	2,320	3,090	3,360	3,770	4,050
Concessions					
Non-Secure	1,650	1,650	1,650	1,650	1,650
Secure	375	375	375	375	375
Restrooms					
Non-Secure	1,435	1,435	1,435	1,435	1,435
Secure	1,705	1,705	1,705	1,705	1,705
Inbound Baggage Drop-Off	1,200	1,200	1,200	1,200	1,200
Baggage Claim	977	974	1,147	1,348	1,550
Baggage Claim Hall	1,750	1,750	1,750	1,750	1,750
Car Rental	230	230	230	230	230
SARA	150	150	150	150	150
Sub-Total Building	**25,689**	**26,456**	**26,899**	**27,510**	**27,992**
Building Systems, Structure @ 15% of Program Space	3.853	3,968	4,035	3,821	4,199
Total Building	**29,542**	**30,424**	**30,934**	**31,637**	**32,191**

Source: Mead & Hunt analysis.

Note: [1] Based on a 65-foot-long checkpoint (including document check stations) and an 8-foot wide corridor.

Terminal Curbside

Vehicular access to the existing terminal curbside is via the approximately 20-foot wide, one-way frontage road accessible from North Hargis Road/West Airport Road, which runs from north to south. Upon reaching the primary terminal curbside, the frontage road splits into four lanes. The first lane is adjacent to the terminal frontage sidewalk, is the main terminal curbside; and is the most frequently used lane. The second lane may be used as an outer curb, for vehicle stacking, as a temporary double-parking lane, or as a pull-out lane. This lane can increase curb capacity equal to the inner lane, depending on maneuverability factors. The third lane serves as a through-lane. The fourth lane, on the east edge of the roadway, is reserved for handicap parking.

The terminal curbside is roughly divided between the arrivals and departures areas of the terminal building. This distinction is recommended to continue for SWO's future terminal plans due to the likely secondary entrance to the ticket hall, an exit from the baggage claim, and a central entrance to the security checkpoint. A bus and hotel courtesy van drop-off/pick-up stop is located at the south end of the existing curb. Vehicle curb lanes will serve all vehicle types: private cars, taxis, transportation network company (TNC) vehicles, ride-hailing services, buses, and hotel courtesy vans.

Curb length methodology requirements are based upon peak hour enplanements. The premise of this formula is that a curbside lane is considered a series of stopping or parking spaces, each accommodating one vehicle and the average number of vehicles each space can serve during a given period is inversely proportional to the average length of time a vehicle occupies a space. Industry standard factors used in the analysis are shown in **Table C-31**.

Table C-31: Percent of Passengers Using Each Travel Mode and Average Vehicle Dwell Time

Mode	Percent	Wait Time (minutes)
Private Vehicle	80%	3
Taxi and TNC	12%	2
Hotel Shuttle	6%	3
Bus	2%	4

Source: ACRP Report 25, Vol. 2, *Terminal Planning Spreadsheet Model, Transportation Research Board, 2010;* Mead & Hunt analysis.

Vehicle curb frontage requirements were determined using peak hour enplanements and deplanements factored by 45 percent for a peak 15-minute period within the peak hour. This represents a peak surge demand of approximately 10 percent. Vehicle stacking or double-parking increases curb frontage capacity, but this should be limited to a maximum of 50 percent of the frontage to maintain maneuverability for vehicles exiting the inner curb and to limit congestion in the bypass lane. Arrivals curb requirements are more significant to account for higher vehicle dwell times. Pedestrian crosswalks needed to access terminal parking areas would increase the linear curbside frontage requirements and should be added to the figures in **Table C-32**.

Table C-32: Vehicle Curb Frontage Requirements

Curb Frontage	2025	2030	2035	2040
Departures	88	100	114	129
Arrivals	94	110	120	138
Total Curbside (linear feet)	**182**	**210**	**234**	**267**

Source: Mead & Hunt analysis.

Vehicle Parking

Passenger and visitor vehicle parking is distributed across four parking lots near the existing terminal building. The lots contain a total of 168 spaces, of which 16 spaces are dedicated to car rental companies. Five spaces are allocated to air traffic control employees in the lot north of the terminal building. The total number of existing spaces available for passenger and visitor parking is 152. A summary of parking space allocation by lot is shown in **Table C-33**.

Table C-33: Existing Terminal Parking and Occupancy

Parking Lot	Existing	Occupancy	Percent
West (of Hargis Road)	50	45	90.0%
East (of Hargis Road)	43	41	95.3%
South	23	21	91.3%
North	36	36	100%
Total	**152**	**143**	**94.1%**

Source: Mead & Hunt analysis.

As shown in the table, SWO's total parking occupancy rate is 94 percent. This parking occupancy is well above the industry threshold of 85 percent, the level at which additional spaces should be provided. Above 85 percent passengers and visitors begin to search for a parking space which can negatively impact their schedules. It has been assumed that the existing figures shown in **Table C-33** represent an average day of the peak month.

Parking figures are typically determined using annual enplanements and utilization figures from peak hour enplanements as a basis for determining future requirements. Using 85 percent as a minimum requirement for planning, the number of required existing parking spaces has been increased by 15 percent of the current total to yield 198. A factor of 4.125 spaces results from dividing 198 by the 2020 peak hour enplanements of 48. Applying this factor to each time period's peak hour enplanements provides the minimum number of parking spaces required. By increasing the factor to 4.75 provides approximately 115 percent of 2020 enplanements, allowing for additional growth over the planning period and additional flexibility during peak activity. **Table C-34** summarizes the parking requirements at SWO throughout the planning period.

Table C-34: Passenger and Visitor Parking

Passenger and Visitor Parking (Including Rental Cars)	2020	2025	2030	2035	2040
Peak Hour Enplanements	48	44	51	58	66
Parking Space Minimum Requirements	230	210	240	275	315

Source: Mead & Hunt analysis.

Use of the parking methodology assumes a duration-of-stay consistent with the existing parking counts. Should future parking surveys (e.g., counting vehicle license plates that remain overnight) indicate that average duration-of-stay increases over time, the parking factor can be increased accordingly. Conducting the surveys at different times of the year would also provide a better understanding of SWO's true customer needs.

Terminal Building Conclusion

The amount of space required to provide sufficient public non-secure and secure terminal building area was calculated to accommodate one scheduled commercial service flight during the peak hour, with the understanding that passengers traveling aboard charter flights could use the terminal when there is no scheduled commercial activity. This includes the departures lounge area prior to boarding. This could improve chartered air carrier and airport operations by removing passengers from the terminal apron during departures and arrivals, assuming a passenger boarding bridge is included in the new terminal (which is recommended).

The analysis indicates that, including university athletic team charter flights, the aircraft size, passenger seats, and potential passenger demand essentially support a two-gate replacement terminal. The use of B 737 aircraft for charter flights requires the following standard to be met as outlined by the FAA's Private Charter Standard Security Program:

> *"The Private Charter Standard Security Program (PCSSP) is for operators with an FAA Part 121, 125, or 135 certificate using aircraft with a maximum certificated takeoff weight greater than 100,309.3 pounds (45,500 kg) or configured with 61 or more passenger seats. The cost of this type of operation is provided by a single entity, not individual passengers. This program includes requirements to screen passengers and their accessible property."*

If charter airlines or SWO allow passengers the use of the departures lounge prior to boarding, this may be perceived as a higher level of service. With a potential for light concessions sales, passengers could purchase goods, food, or beverages and use the restrooms for boarding.

Constructing the initial terminal building with sufficient space to accommodate existing scheduled commercial service and non-scheduled charter service will allow for post-planning period growth, the introduction of a second air carrier during the planning period, or the introduction of an unanticipated second early morning flight to an additional airport. Including the additional space in the new terminal building would benefit SWO and the community by offering opportunity to support these events should they occur. This could increase the community's options, maximize opportunity for competition, and raise the level of passenger service within a modern facility.

An initial two-gate terminal building would increase area requirements, mainly through the addition of a second departures lounge and aircraft apron parking position. The cost of the lounge area would be less than if it were added at a future date. Sufficient space for additional ticketing counters has been provided in the ticket hall should the university athletic teams' charter flights, or a second commercial air carrier, want to lease ticket counters and the accompanying secure operations area. SWO would be responsible for this option, but the cost could be postponed until such time as an air carrier might request these facilities. Providing flexibility for a building with a lifespan of 30 to 40 years will provide SWO the means to adapt to changes in air transportation through and beyond the planning period. It is also recommended that the new terminal building use a single parking lot that can accommodate the full parking needs of SWO's passengers and visitors.

Landside and Terminal Area Support Facilities

General Aviation Facilities

GA facilities support and serve the based and transient airport users through aircraft storage, pilot and passenger amenities and services, and aircraft maintenance. GA traffic at SWO represented approximately

91.8 percent of total operations in 2020 and is expected to compromise 94.3 percent by 2040. Based aircraft are expected to increase from 80 in 2020 to approximately 101 in 2040.

Fixed Base Operators

FBOs are businesses providing aircraft services such as fuel sales, aircraft maintenance, flight training, and aircraft storage. Currently, Stillwater Flight Center is the sole FBO at SWO. The facility requirements for FBOs depend on staffing and equipment needs to keep up with an anticipated increase in demand. New or expanded FBO buildings might be necessary as the existing facility reaches capacity.

Aircraft Hangar Storage

Based on the high investment of owning and operating aircraft, hangar storage is generally the most desired option for both short- and long-term aircraft storage. Aircraft hangar storage at SWO consists of 20 T-hangar units, 19 large group storage hangars, and four individual "Port-A-Port" hangars. T-hangars are designed to house one small aircraft per space, while group hangars are designed to house larger aircraft or multiple smaller aircraft. Port-A-Port hangars are short-term T-hangars owned by the City of Stillwater. **Table C-35** presents the estimated aircraft hangar storage demand throughout the planning period.

Table C-35: Hangar Storage Analysis, 2020-2040

Hangar Type	2020	2025	2030	2035	2040
Based Aircraft	80	87	91	96	101
Total Hangar Spaces	**43**	**48**	**52**	**56**	**58**
T-Hangar Units	24	28	30	32	34
Group Hangars	19	20	22	23	24

Source: Mead & Hunt analysis using forecast projections.

As of 2020, there are 0.54 hangar spaces to every based aircraft at SWO, confirming that group hangars are storing multiple aircraft. This ratio is used to estimate future storage recommendations, as it is expected that future storage facilities will reflect many of the existing characteristics of the current storage patterns. While the existing Oklahoma State University (OSU) fleet of 37 aircraft are based almost exclusively outside on apron tiedowns, SWO personnel indicate no other based aircraft use apron tiedown storage.

The based aircraft forecast presented in **Chapter B – Forecasts of Aviation Activity** projected an increase of 16 single engine aircraft, two jet aircraft, one helicopter, and two light sport aircraft from 2020 to 2040. The number of multi-engine aircraft are not ultimately expected to change from 2020 to 2040. The OSU fleet of aircraft is expected to increase somewhat during the planning period, and these aircraft will likely remain based outside until such time that funding can be arranged to construct covered parking. In consideration of similar storage preference characteristics, it is expected that additional T-hangar units will be needed to correspond with the increase in single engine aircraft. Group hangars should be added to accommodate any additional single engine aircraft as well as the other larger aircraft types. The actual number, size, and location of future hangars will depend on user needs and financial feasibility at the time demand occurs.

Aircraft Apron Storage

As previously listed in **Chapter A – Inventory of Existing Conditions**, there are six aprons at SWO that will collectively provide approximately 109 aircraft tiedowns when all aprons are constructed.

GA apron storage requirements typically are based on the estimated amount of itinerant and based aircraft using tiedowns or apron storage spaces. Itinerant aircraft typically only require short-term, temporary storage on an apron, while based aircraft, if using tiedowns, typically have need of longer-term requirements until additional hangar spaces are provided.

Apron space calculations use 400 square yards of apron per itinerant aircraft and 300 square yards of apron per based aircraft. There are two reasons for this:

- Itinerant aircraft users will not be as familiar with the layout and circulation patterns at SWO so additional maneuvering space is essential.
- Whereas typically smaller, single engine based aircraft use apron storage, itinerant aircraft of various sizes do and will continue to use temporary apron storage at SWO.

Larger military aircraft are also regularly accommodated on the aprons. Therefore, it is necessary to provide additional apron area to accommodate the larger aircraft. As presented in **Table C-36**, the amount of anticipated demand for GA apron space is expected to exceed existing capacity during the planning period.

Table C-36: Apron Storage Requirements, 2010-2040

Apron Type	2020	2025	2030	2035	2040
Projected Apron Requirements	**34,786**	**39,719**	**42,799**	**46,543**	**50,283**
Itinerant GA Aprons	22,576	27,509	30,589	34,003	37,083
Based GA Aprons[1]	12,210	12,210	12,210	12,540	13,200
Existing Apron Area	**39,502**	**39,502**	**39,502**	**39,502**	**39,502**
Itinerant GA Aprons[2]	21,166	21,166	21,166	21,166	21,166
Based GA Aprons[3]	18,335	18,335	18,335	18,335	18,335

Source: Mead and Hunt analysis using forecast projections.

Notes: Apron areas calculated for area available for aircraft parking.

[1] The total number of OSU based aircraft is expected to remain stable through 2030 as older aircraft are replaced. A slight increase is expected thereafter through 2040.

[2] Itinerant aprons are currently located on the Terminal, Hangar 1, and Southeast General Aviation Ramps.

[3] Based aprons are currently located on the University Flight Center North and South Ramps, and they are only used for basing OSU aircraft.

Following completion of the University Flight Center South Ramp, all OSU based aircraft will be moved to tiedowns in this area. The existing University Flight Center North Ramp is then likely to be used for itinerant aircraft tiedowns.

With the evolving technologies of electric propulsion and enhanced battery capacity, electric Urban Air Mobility (UAM) and Vertical Takeoff and Landing (eVTOL) aircraft are expected to become a larger part of the nationwide fleet in the future. SWO should plan and program for adequate area to accommodate at least one electric aircraft charging station accommodating ADG II aircraft. This translates into an approximate 9,300 square feet of apron area (including adequate wingtip clearance). The preferred location would be near the edge of the designated itinerant apron where adequate electrical power supply can be accessed.

General Aviation Facilities Conclusion

To accommodate the projected growth in single-engine aircraft, T-hangar structures should be increased by approximately 10 over the planning period. Group hangars should be increased by approximately five to account for the forecasted growth in the remaining aircraft. It is anticipated that additional GA apron space for itinerant aircraft will be required, including one charging station for electric aircraft.

Air Cargo Facilities

Currently, air cargo aircraft use the terminal apron just southwest of the terminal building for loading and unloading of air cargo directly onto the aircraft to and from the delivery trucks. This location provides easy access for the delivery trucks to the apron. It is expected that this location will continue to be utilized for air cargo loading throughout the planning period.

Air Cargo Facilities Conclusion

The air cargo facilities are sufficient in size and can accommodate air cargo throughout the planning period.

Large Scale Aeronautical Facilities

The presence of the recently completed OSU Flight Center at SWO is part of the continued expansion of the Oklahoma Aerospace Institute for Research and Education (OAIRE) that was announced in late 2021. It will be the first Aerospace Institute in the state of Oklahoma and twice the size of any facility in the country. Coupled with OSU’s Research and Development (R&D) opportunities for Unmanned Aerial Systems (UAS) and the State Department of Commerce’s strong support for aeronautical development, many potential opportunities exist to provide additional offerings for training, educating, and certifying students for careers in the aviation industry. Careers in aircraft Maintenance, Repair, and Overhaul (MRO), education, and experimental aircraft enterprises can be expected. With the likely influx of aviation-focused students, SWO will become more attractive for additional aviation entities to invest in facilities.

Large Scale Aeronautical Facilities Conclusion

It is not anticipated that SWO's west side property will be required for GA facilities within the planning period. Therefore, the reservation of adequate space for large-scale aeronautical development immediately west of Runway 17/35 and northwest of Runway 4/22 should be planned and protected for non-GA aeronautical uses.

Airport Traffic Control Tower (ATCT)

The existing ATCT is located atop the terminal building connected to the ticketing area with an open stair from the common area up to the conference room on the second level. Access to the upper three levels that define the ATCT facilities is controlled though a secure locking mechanism at the second-floor door opened only with the correct entry of numerical codes. The level directly above the conference room is an equipment room; the level above that is a breakroom/toilet area for the ACTC personnel. The 600 square feet of space within the ATCT cab is the highest structure within the building.

Siting requirements for ATCTs are found in FAA Order 6480.4B, *Airport Traffic Control Tower Siting Process*, and AC 150/5300-13B, *Airport Design*. Accessibility requirements for people with disabilities to public buildings is described in Title II of the 2010 Standards for Accessibility, commonly called the Americans with Disabilities Act (ADA).

ATCT Requirements

Generalized ATCT requirements are summarized below. ATCT buildings must:

- Provide sufficient height to have unobstructed views of all controlled aircraft movement areas including runways, taxiways, and ramp areas, as well as airborne traffic patterns and runway approaches, having a perpendicular line-of-sight (LOS) with the primary runway/taxiway system.
- Provide sufficient height such that the LOS angle of incidence to the key point on the airfield is equal to or greater than 0.80 degrees.
- Orient so the primary operational view faces north, or alternatively east, west, or south in that order of preference.
- Prevent the impairment of visibility by direct or indirect external light sources, sunlight, reflective surfaces, naturally occurring atmospheric conditions, and industrial/municipal discharges.
- Prevent degrading or affecting the performance of existing or planned communications, navigation, or surveillance equipment.
- Avoid adverse impacts to any current or planned terminal instrument procedures.
- Comply with Federal Aviation Regulations (FAR) Part 77, *Objects Affecting Navigable Airspace* and all airport design criteria surfaces.
- Comply with the ADA public access requirements if the existing terminal building is remodeled and the existing ATCT is to remain.

- Comply with all safety and security regulations contained in FAA Order 1600.69C, *FAA Facility Security Management Program* commensurate with the Facility Security Level (FSL) assigned to the ATCT.

ATCT Analysis

An analysis of the existing ATCT LOS indicates that no obstructions block the view of any runway surfaces and most taxiway surfaces. However, as illustrated in **Figure C-3** the tops of Group Hangars 1 and 2 obscure a segment of Taxiway F from ATCT LOS, as are all the ramps northeast of Group Hangar 1 including the OSU Flight Center Ramp North. Additionally, most of the Southeast GA Taxilane is obscured from ATCT LOS by the hangars located north of the taxilane. In interviews, ATCT personnel have confirmed these LOS issues. They also report that a taller cab elevation at the current location might eliminate the LOS issue and taller windows in the cab would be preferrable.

The existing LOS angle of incident as calculated to the key point on the airfield (i.e., Runway End 17) is 0.04, meaning the controller eye height elevation (1003.7 feet AMSL) is barely above the Runway End 17 elevation (1,000 feet AMSL). This angle of incident does not meet the requirements in FAA Order 6480.4B, which as previously stated is a minimum 0.80 degrees.

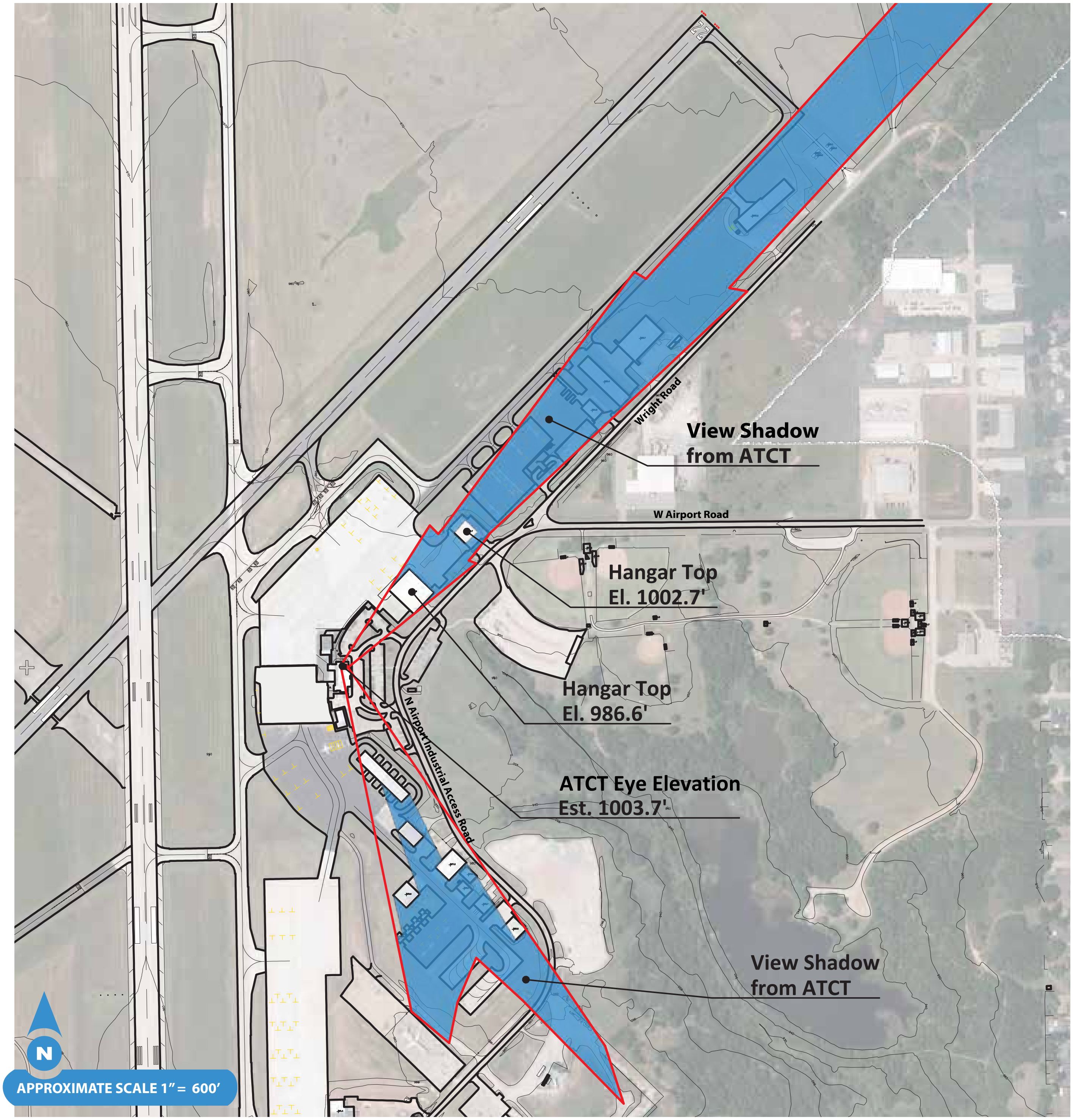
The status of the life safety requirements such as exit requirements and smoke proof enclosures along with fire rated partition locations have not been documented. Fire protection and fire and smoke detection are also potentially out of date.

Security concerns exist regarding reasonable provisions for employee parking. Currently, there is inadequate parking at the terminal and the ATCT personnel share parking spaces with other users on the terminal building.

The current equipment room is a little larger than a closet and does not have adequate heating, ventilation, and air conditioning (HVAC), leading to equipment overheating and the inability for the tower to install additional equipment needed for backup and redundancy purposes. The employee breakroom and restroom is extremely small by modern standards.

The existing ATCT is not accessible to people with disabilities. However, the multi-story buildings Section 206.2.3 of Title II of the ADA states that air traffic control towers have an exemption from the requirements to have an elevator that serves both the cab and one floor below. Given that the space located two-levels below is an equipment room, this level would be exempt from the elevator requirements also. Title II of the ADA does not allow for elevator exemptions for all public areas of new or renovated airport terminals. Therefore, should the decision be made to remodel the existing terminal building and retain the existing ATCT in its present location, ADA requirements include the installation of either an elevator or a vertical platform lift to the second floor of the existing terminal (i.e., the airport conference room) as part of the renovation process.

To improve security, it is expected that the conference room will be set aside for use by ATCT personnel only. Controlled access will require a separate entrance into the facility and will be designed to minimize the usability of the existing terminal building.



Stillwater Regional Airport OKLAHOMA SWO

Figure C-3
ATCT Line of Sight Analysis

Airport Traffic Control Tower Conclusion

Given that the existing ATCT is located atop the existing terminal building, the sizable cost to provide an elevator or vertical platform lift to the second floor if the existing terminal building is remodeled will be questionably spent. Spending construction monies on improving the ATCT in the existing location is not practical considering a replacement facility will likely be constructed in less than ten years due to the antiquated design. Long-term cost savings can be achieved by separating the tower from the terminal during the upcoming remodel rather than performing another renovation a few years later. Segregating a secure entrance and providing secure parking for ATCT personnel will minimize the usability of the existing terminal building and parking areas. Additionally, it is unknown at this time if the existing ATCT will structurally support additional height that would alleviate the unobstructed LOS issues with Taxiway F and the Southeast GA Taxilane, and the inadequate LOS angle of incident.

It is recommended that a future ATCT location be evaluated. Since the primary runway (Runway 17/35) is oriented north-south, and perpendicular LOS is preferred with an east facing view being the second-most advantageous orientation, a site on the west side of SWO is recommended for evaluation in the next chapter, **Chapter D – Alternatives Analysis**.

While this Master Plan will evaluate and recommend a future ATCT location, the use of the Airport Facilities Terminal Integration Laboratory (AFTIL) method or the Alternate Siting Process (both outlined in Order 6480.4B) is required. A follow-on ATCT Siting Study will need to be prepared separate from this Master Plan to either confirm the recommended site or select another location. Close coordination with and review by the Technical Operation Services Air Traffic Organization (AJW) Terminal Facilities Execution will be conducted before an official written decision memorandum of a new ATCT site can be provided.

Aircraft Rescue and Fire Fighting Facility

According to Code of Federal Regulations (CFR) Part 139.315, ARFF equipment and staffing requirements are based upon the length of the largest air carrier aircraft that serves an airport with an average of five or more daily departures. **Table C-37** presents the ARFF Index, aircraft length criteria, and representative air carrier aircraft.

Table C-37: ARFF Support Requirements

ARFF Index	Aircraft Length	Representative Aircraft
A	Less than 90’	ERJ 135, CRJ 200
B	At least 90’ but less than 126’	CRJ 900, A319/A320, **ERJ 145[E]/175[F]**
C	At least 126’ but less than 159’	ERJ 195, A321, B 737-800/900
D	At least 159’ but less than 200’	B 757, B 767, A330
E	At least 200’	B 747, B 777, A340

Source: CFR Part 139.315 ARFF Index Determination.

Notes: **Bold** = SWO critical aircraft, [E] – Existing, [F] – Future.

SWO currently holds an ARFF index designation of B, with Index C services provided with prior arrangement. The Index B designation is due to the average commercial operations of two departures daily of the ERJ 145, which is the existing critical aircraft. The ERJ 175 is the forecasted future critical aircraft. Both aircraft are within the ARFF index B classification. The Index C provided services accommodate the longer aircraft used by OSU and visiting universities athletic teams.

The existing ARFF facility is centrally located on the east edge of the terminal apron just south of the terminal building. It provides approximately 1,110 square feet and is comprised of one vehicle storage bay. An additional bay is leased in tandem with the adjoining apartment. While an older structure the ARFF is in good functioning condition. SWO's ARFF facility currently operates two vehicles, which were detailed in **Chapter A – Inventory of Existing Conditions**. The existing equipment can accommodate the necessary requirements for its current ARFF index. However, SWO desires to store both ARFF vehicles indoors with ample equipment and material storage and maintenance space provided.

ARFF Conclusion

It is recommended that alternative locations for a new ARFF building providing two vehicle bays and ample storage and maintenance area be analyzed in the next chapter. Additionally, SWO should engage with an engineering or architectural firm to right-size the ARFF building space and layout to best conform with FAA guidance, as well as with local codes and ordinances.

Snow Removal Equipment and Airport Maintenance Facility

Airport maintenance is responsible for the upkeep, protection, and preservation of airport facilities and snow removal equipment (SRE) is used for snow and ice removal from airport pavements. Facilities that are right sized to store equipment and material is an important part of the airport planning process. Currently, SWO does not have a dedicated SRE facility, so equipment is stored outdoors and indoors where space is available. A recently initiated project will demolish the decommissioned plane wash bay and enlarge the existing administration and operations building to include additional indoor equipment storage.

FAA AC 150/5220-20A, *Airport Snow and Ice Control Equipment*, provides guidance in the purchase of AIP-eligible SRE. AC 150/5220-18A, *Buildings for Storage and Maintenance of Airport Snow and Ice Control Equipment and Materials*, provides siting factors and space allocation calculation for SRE facilities. FAA AC 150/5200-30D, *Airport Field Condition Assessments and Winter Operations Safety*, provides guidance to airport sponsors in developing snow and ice control plans.

SRE Requirements

The minimum SRE requirements at commercial service airports are primarily based on three factors: the total square footage of designated Priority 1 paved area identified in the winter storm management plans, the annual aircraft operations, and the amount (in tonnage) of snow to be removed in a given time period. Priority

1 paved areas are defined as the primary runway, parallel taxiway, terminal ramp, control tower access, and ARFF access. In SWO's *Snow and Ice Control Plan*, approved by the FAA in June 2021, the following are identified as Priority 1 areas:

- Runway 17/35
- Taxiways A, A3, A4, and C
- Terminal/airline apron
- ARFF access ramp
- Southeast GA Taxiway to the Airport Operations and Maintenance Center and Administration Offices
- ILS equipment roadways (glideslope and localizer antennas)
- PAPIs

This amounts to over 1,335,000 square feet of Priority 1 pavement, which classifies SWO as a large airport by AC 150/5220-18A.

Commercial service airports with more than 40,000 aircraft operations should have equipment to clear the Priority 1 surfaces of one inch of snow weighing up to 25 pounds per cubic foot in 30 minutes. The calculations for SWO indicated approximately 3,980 tons of snow is removed per hour assuming one inch of snow accumulation. However, SWO's current *Snow and Ice Control Plan* sets the removal time at one hour.

The FAA online snow removal equipment calculator provides a recommended amount of SRE. It is possible for equipment to be multi-purpose that combines multiple functions on one platform (e.g., a plow truck may also double as a hopper spreader, and an assortment of quick-change attachments allow a vehicle to convert from one function to another). **Table C-38** presents the existing SRE equipment at SWO and the equipment recommendations based on these calculations. Based on the assumptions and calculations presented in this analysis, SWO is eligible for two Class III high-speed rotary plows with the capacity to cast 2,500 tons of snow per hour a distance of 100 feet. The rotary plows should be supported by four snowplows of equal snow removal capacity, equaling 40 feet of actual blade length with a 30-degree plow cutting angle and a 20-mile per hour operating speed.

SWO currently meets these minimum equipment requirements; however, it appears that SWO is eligible for two sweepers that are available at its discretion through AIP funding. It is recommended that SWO replace or supplement the existing SRE vehicles that do not meet the requirements or that have exceeded the expected useful lifespan (i.e., generally 10 to 15 years). SWO is planning to replace the two existing rotary plows with newer equipment in Fiscal Year 2022. The existing SRE vehicle inventory that does not meet the recommendations could be used to clear secondary and tertiary paved areas such as GA aprons, taxilanes, hangar areas, access roads, automobile parking, and off-airside surfaces.

Table C-38: AIP Eligible SRE Recommendations

Equipment	Existing	Recommended
Rotary Plows (Snow Blowers)	• Two Blizzard Buster 12-foot Tow-Behind Brooms	• Two Class III
Plows	• Snow Dog Plow 9-foot truck mounted • Tractor mounted 12-foot snow pusher box • Dump Truck mounted 11-foot plow • Sand truck mounted 10-foot plow • Motor grader with 14-foot blade	• Four Class III with a total 40-foot blade length
Multi-Purpose Equipment	• Wyle 800-gallon towed motorized chemical de-ice sprayer with 42'foot boom • New Holland Skid Steer with bucket • ATV-mounted de-ice granular spreader	• Two Sweepers • Two Hopper Spreaders

Source: SWO Snow and Ice Control Plan, dated June 10, 2021, and Mead & Hunt analysis using FAA AC 150/5220-20A.

SRE and Airport Maintenance Facility Requirements

SRE is a costly piece of complex and technologically advanced equipment. To protect and service equipment, and to protect local and federal investment, specifically designed maintenance and storage buildings are needed. SRE should be housed in a building capable of maintaining a temperature of 50 degrees Fahrenheit to prolong the useful life of the equipment and to enable more rapid response to operational needs.

Total space allocation for an SRE facility is based on the total of three individual areas determined necessary to meet different functional purposes:

- **Storage area** (including equipment parking, snow and ice control materials, and equipment parts)
- **Support area** (including administrative and equipment maintenance areas)
- **Special equipment area** (including heating, ventilation air conditioning, steam generation, emergency power, and machine rooms).

Space allocation for each area is determined by local building code and ordinance, values provide by tables in AC 150/5220-18A, and applying equipment clearance values as determined by using equipment safety zone concepts.

Using this guidance, a total SRE and airport maintenance facility consisting of approximately 15,500 square feet[3] is recommended. Thus, since the existing facility is approximately 9,000 square feet, with plans to expand to expand to approximately 13,000 square feet, the SRE needs exceed the existing conditions.

SRE and Airport Maintenance Facility Conclusion

It is recommended that SWO continue programming for the replacement of the existing antiquated SRE vehicles that do not meet the recommendations presented in this analysis or have exceeded their useful lifespans with equipment that are eligible for AIP funding. Alternative sites for a future SRE and Airport Maintenance Facility will be examined in the next chapter. Additionally, as with the ARFF building, SWO

[3] Includes storage area allocation for two self-propelled rotary snowplows, four trucks and/or tractors for snowplow operations, four 10-foot-long snow blades, two 10-foot sweepers, and two spreader hoppers. Support area allocation does not include sleeping quarters but does include a lunchroom, kitchen, a cleaning bay, and a repair bay.

should engage with an engineering or architectural firm to right-size the SRE building space and layout to best conform with FAA guidance, as well as with local codes and ordinances.

Fuel Storage Facility

The City of Stillwater owns the SWO fuel storage facility, which provides both Jet A and 100LL AVGAS. According to fuel sales records provided by SWO, there has been an average of 123,456 gallons of Jet A and 123,456 gallons of 100LL AVGAS sold during the past four years (i.e., 2017-2020). Based on the 2020 total aircraft operations, this equates to approximately 79.7 gallons of Jet A fuel sold per turbine-powered aircraft operation and 2.0 gallons of 100LL AVGAS fuel sold per piston-powered aircraft operation.

Typically, as operations increase, fuel storage requirements can be expected to increase proportionately. Current aircraft trends at SWO indicate that GA aircraft are more frequently used for business purposes and less for recreation or leisure purposes. The distance travelled for aircraft being used for business purposes is typically longer compared to recreation or leisure aircraft. Coupled with the continued increase in training operations by the OSU Flight Center, aviation fuel trends suggest that the ratio of 100LL AVGAS gallons sold per operation will slightly increase throughout the planning period. Additionally, with the airlines transitioning from 50-seat aircraft to larger 76-seat aircraft, and larger business jets continuing to use SWO, the ratio of Jet A gallons sold per operation will also increase. Using the increasing gallons sold per operation ratio, an estimate of fuel storage needs can be calculated as a two-week supply during the peak month of operations, which is an industry rule-of-thumb planning standard. **Table C-39** presents the demand for fuel storage compared to the existing capacity.

Table C-39: Fuel Storage Requirements, 2020-2040

Fuel Type	2020	2025	2030	2035	2040
Jet A					
Average Day of Peak Month Turbine-Powered Aircraft Operations	15	18	20	22	24
Two Weeks of Operations	213	256	287	311	39
Gallons Per Operation	79.7	80.0	82.0	84.0	86.0
Forecast Fuel Storage Demand	17,000	20,480	23,515	26,110	29,140
Actual Fuel Storage (gallons)[1]	24,000	24,000	24,000	24,000	24,000
Fuel Storage Excess/Deficiency (gallons)	2,200	-1,280	-4,315	-6,910	-9,940
100LL AVGAS					
Average Day of Peak Month Piston-Powered Aircraft Operations	254	317	349	373	396
Two Weeks of Operations	3,556	4,437	4,884	5,222	5,548
Gallons Per Operation	2.0	2.2	2.3	2.3	2.3
Forecast Fuel Storage Demand	7,105	9,760	11,230	12,010	13,315
Actual Fuel Storage (gallons)[2]	20,000	20,000	20,000	20,000	20,000
Fuel Storage Excess/Deficiency (gallons)	8,895	6,240	4,770	3,990	2,685

Source: Mead & Hunt analysis.

Notes: [1] Existing Jet A fuel storage capacity (80 percent of storage tank capacity is considered full).

[2] Existing 100LL AVGAS fuel storage capacity (80 percent of storage tank capacity is considered full).

Fuel Storage Facility Conclusion

It appears that the existing Jet A fuel storage capacity is somewhat undersized and additional capacity may be needed in the future based on the generalized planning standard. The existing fuel storage area has sufficient space to either include additional fuel storage tanks or replace older tanks with new larger tanks.

Non-Aeronautical Tenants and Ground Facilities

SWO-owned property provides opportunities for potential non-aeronautical tenants to occupy space and generate revenue to help fund airport operations and future improvements. Continued population and job growth are the result of a desirable quality of life, a well-educated labor base, a high-quality public institution in OSU, a central presence in the United States, and strong community support. These competitive strengths and assets provide the opportunity to accommodate a variety of non-aeronautical land use needs on portions of airport property, thereby benefitting SWO, the City of Stillwater, and the surrounding region.

According to Woods & Poole projections, Payne County is expected to add over 8,800 jobs from 2020 to 2040, representing an approximate 0.8 percent Compound Annual Growth Rate (CAGR). As the largest city in Payne County, Stillwater would be expected to add the most jobs within the county. SWO has ample undeveloped property to accommodate some of this job growth as it relates to non-aeronautical tenants.

The continued growth and cultivation of commercial passenger service at SWO over time should stimulate non-aeronautical development related to ancillary travel services. With the nearby softball fields, a right-sized hotel may be supportive of both the commercial air carrier passengers and crew using SWO, as well as the users of the adjacent public use facilities. Commercial establishments, such as convenience stores, gas stations, and restaurants serving both SWO and the surrounding community, could be viable options for development. With the current and planned configuration of the road system along the east side of SWO, access and capacity would be attractive for these types of future small-scale development. Currently, the closest hotel is more than three miles from SWO.

The west side of SWO not reserved for aeronautical development affords the opportunity for development of large-scale non-aeronautical tenants. These property parcels are currently zoned as public/light industrial. This property is situated in a favorable location for long-term opportunities as the needs arise and supporting infrastructure can be supplied. The area surrounding SWO is not generally a preferred location for office and commercial space users, so market expectations seem to support R&D facilities and light industrial type development on SWO's west side. It could also include facilities consisting of warehouses or cargo handling and sorting facilities. Any large-scale development would need to be sited and constructed in consideration of Federal Aviation Regulations (FAR) Part 77 imaginary surfaces regulating height restrictions.

Non-Aeronautical Tenants and Ground Facilities Conclusion

It is recommended that options for the provision of non-aeronautical facilities, and the infrastructure needed to support it be evaluated and identified in the next chapter, **Chapter D – Alternatives Analysis**. This includes property on both the east and west sides of SWO.

Airport Access, Circulation, and Truck Routes

Stillwater's major access roadways are the north-south oriented US Highway 177 and east-west oriented State Highway 51, which meet in the middle of the City of Stillwater. State Highway 51 intersects with Interstate 35 (I-35) approximately 16 miles west of Stillwater and US Highway 177 intersects with the Cimarron Turnpike Spur approximately five miles to the north.

SWO is accessible by vehicle, truck, and bus. The primary access to SWO from the south is Airport Industrial Road (recently renamed North Hargis Road), which runs from the intersection of North Western Road and West Lakeview Road to the intersection of West Airport Road just east of the terminal building. West Airport Road is SWO's primary access from the east, which intersects with North Washington Street (US Highway 177) approximately 3/4 miles to the east. Current plans include a complete realignment of North Hargis Road so that it would be located further east of the terminal area, as illustrated in **Figure C-4**.

When Hargis Road is relocated, the existing roadway network will continue to provide access and entrance points for all passengers, employees, tenants, and other ground operators, including access to the terminal parking areas. Connectivity with the relocated Hargis Road will be maintained at two locations at the north and south ends.

The realigned North Hargis Road will be a two-lane roadway constructed of asphalt. Using the Highway Capacity Software, the one-way capacity of a 35 mile per hour (mph) roadway with no curb and gutter results in an Annual Average Traffic (AADT) of 1,650 cars per day. The capacity for a two-lane facility doubles to 3,300 cars per day, which is the effective AADT of the realigned North Hargis Road. According to traffic counts for Hargis Road measured approximately one quarter mile north of the intersection with West Lakeview Road, AADT for 2022 is equal to 1,822 cars per day. Using an annual increase in traffic of about 2.0 percent yields approximately 2,404 cars per day by 2042. The capacity of North Hargis Road is well over the existing and forecasted demand for the vehicle traffic. Once North Hargis Road is realigned, there will be no need for further improvements except for additional access points as needed to serve future tenants.

West Airport Road is a two-lane road, and thus also has a capacity of 3,300 cars per day. According to traffic counts for West Airport Road measured approximately one quarter mile west of the intersection with North Washington Street/Highway 177, AADT for 2022 is equal to 2,413 cars per day. Using an expected annual traffic increase of about 2.6 percent, AADT is expected to increase to 3,480 cars per day. Based on this analysis, future traffic on West Airport Road will likely exceed the road's capacity. It is recommended to closely monitor traffic conditions so that demand does not exceed capacity before improvements are provided.

With the potential development of SWO's west side property, there will be a need to provide vehicular access. Most likely this access will be provided by improvements made to West Airport Road from the west via 3310 Road and its connection to West Lakeview Road.

Considering vehicle circulation at the terminal and the provision of future parking areas, it is recommended that terminal reconfiguration alternatives be evaluated that increase parking areas and improve passenger

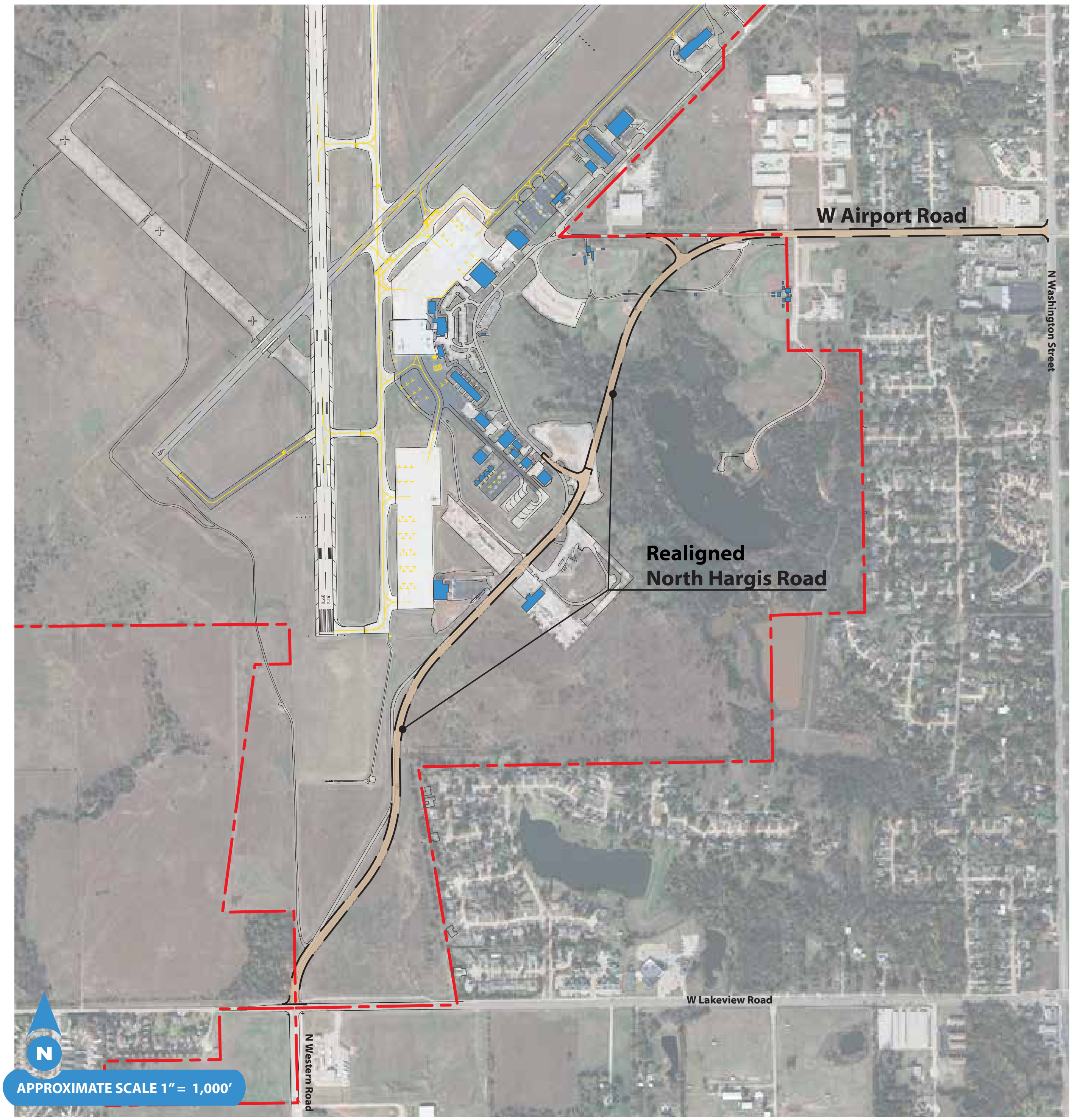


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Figure C-4
North Hargis Road Realignment

pick up/drop off vehicle lanes. This could be accomplished while maintaining clear routes to the GA facilities to both the north and south of the terminal area.

According to the National Highway Freight Network, there are two primary truck routes that pass within approximately 30 miles of SWO. These routes are I-35, running north/south through the center of the state, and Interstate 44, running northeast/southwest from Oklahoma City to Tulsa. Neither truck route has or is planned to have an impact on SWO.

There is a railroad that runs through the City of Stillwater, called the Stillwater Central Railroad. This railroad continues to the north and then connects into the BNSF railroad network. Presently there are no stubs that extend to SWO property, and it is not anticipated that a connection will be provided during the planning period.

Access, Circulation, and Truck Routes Conclusion

It is recommended that the current airport access be maintained in the existing location once North Hargis Road is realigned. In conjunction with the terminal building alternatives evaluation, various vehicle access points, circulation routes, and parking facilities will be analyzed and considered. Traffic conditions on West Airport Road east of the intersection with the relocated North Hargis Road should be monitored so that capacity improvements can be provided accordingly.

Utilities

The major utility systems at SWO include water, sanitary sewer, stormwater drainage, electric, natural gas, and communications, which were assessed for their ability to accommodate the requirements of any future development that might reasonably be expected to occur at SWO (e.g., hangar development, apron expansion, and new or expanded aeronautical or non-aeronautical facilities). Water and waste water are analyzed separately below, but the existing stormwater drainage, electric, natural gas, and communications utilities are adequate to meet the existing and anticipated demand.

Water Usage

Metered water usage information was gathered from the City of Stillwater's billing system for all meters registered to the city from 2015 through 2019, which includes meters serving the terminal building and various SWO support facilities. Not included in this review were meters registered to private third parties, which support private hangars and other establishments.

Meter water usage was compared to passenger enplanement, commercial service operations, and air cargo volume on an annual basis. No correlation was found between metered water usage and passenger enplanement, commercial service operations, or air cargo volume for the period reviewed. While commercial service operations and air cargo volume remained relatively steady for all five years and passenger enplanement was relatively stable from 2017 through 2019, annual metered water usage varied from a high of 244,000 gallons in 2016 to a low of 66,000 gallons in 2019. The reason for the variation in water usage was not known, but it could be attributed to construction activities or variations in operation and maintenance procedures. An average of 4.4 gallons of water per passenger enplanement were used for the period of 2017 through 2019.

The peak month water usage during the review period was October of 2016. This month’s usage was 46,800 gallons, an average usage rate of one gallon per minute or 1,560 gallons per day. SWO’s metered water usage has historically been very low, particularly compared to its fire flow demands. If adequate capacity for fire protection is maintained for SWO, sufficient domestic flow would surely be maintained for even very large increases in passengers, air cargo, or commercial service operations. SWO is served by a 12-inch water line and 8-inch sanitary sewer line, which, by observation, should be more than sufficient to serve the airport’s domestic needs.

Utilities Conclusion

The utility systems at SWO are observed to be sufficient for the existing and future needs, and no alterations are necessary.

Perimeter Security

The security fence that surrounds the airport property is an 8-foot chain link topped with three strands of barb wire. There are 21 secure vehicle gates placed at strategic locations around the perimeter fence providing access from the non-secure landside areas to the secure landside and airside facilities. There are ten pedestrian gates providing secure access to aprons, hangars, and airside facilities. Three are near the airport administration building providing access to the south corporate hangar ramp, with an additional gate currently being provided near the Cowboy Hangar. Four are located near the terminal building and four are in the northeast hangar development area. SWO staff indicate that the existing perimeter security system is generally adequate for existing and future needs. However, increased cameras and automated gates would improve security at SWO.

There is no existing continuous perimeter roadway system. SWO has used gravel and millings from city roadway projects to improve the rougher areas near the security fence for what are the beginnings of a perimeter road. A continuous paved perimeter road would make the patrolling of the airport perimeter possible in all weather conditions.

Perimeter Security Conclusion

SWO staff indicate the security perimeter fencing and access gate system are generally adequate for existing and future needs. However, increased cameras for improved airfield surveillance, additional automated gates, and a continuous paved perimeter road are recommended.

SUMMARY

The information provided in this chapter provides the basis for understanding the facility improvements that are needed at SWO to accommodate future aviation demand efficiently and safely. Following are the major improvement considerations that have been identified in this chapter.

Airside Considerations

Instrument Approach Procedures and Navigational Aids

- Evaluate the potential to implement a GPS-based IAP providing visibility minimums of 1/2 mile to Runway End 35 and NPA IAPs providing visibility minimums not less than 3/4 mile to Runway Ends 4 and 22.

Airfield Design Standards

- Evaluate remediation of the deficient Runway 17/35 ROFA width, as well as the deficient Runway 4/22 ROFA and ROFZ width.
- Monitor the pavement strength of the apron surrounding T-hangar 2.

Pavement Marking, Lighting, and Signage

- Evaluate potential installation of a full approach light system, such as a MALSR, in conjunction with the potential Runway End 35 IAP improvement.
- Evaluate installation of non-precision threshold markings in conjunction with Runway End 4 or 22 NPA.
- Replace all LED edge lighting with incandescent lighting.

Taxiway/Taxilane System

- Redesign Taxiway F1 to a right-angled taxiway.

Landside Considerations

Terminal Building

- Construct a new terminal building approximately 32,000 square feet in total size incorporating appropriate programmed space needs to meet the anticipated passenger demand.

General Aviation Facilities

- Construct approximately 10 additional T-hangar spaces and five additional group hangars over the planning period.
- Evaluate additional GA apron space for itinerant aircraft.

Large Scale Aeronautical Facilities

- Evaluate property reservation west of Runway 17/35 and northwest of Runway 4/22 for non-GA aeronautical uses.

ATCT Facility

- Reconstruct ATCT building in a new, physically separated location from the terminal building.
- Evaluate suitable locations for the relocated ATCT building using the AFTIL Alternate Siting Process and a subsequent ATCT Siting Study.

ARFF Facility

- Reconstruct the ARFF building in a new location, right-sizing the space to best conform with FAA guidance or other local building codes.
- Evaluate suitable locations for the relocated ARFF building.

SRE and Airport Maintenance Facility

- Program the replacement of the existing SRE vehicles no longer fulfilling their primary function or exceeding their useful lifespans.
- Evaluate sites for a future SRE and Airport Maintenance Facility, right-sizing the space to best conform with FAA guidance or other local building codes.

Fuel Storage Facility

- Evaluate future expansion of Jet A fuel storage in accordance with demand.

Non-Aeronautical Tenants and Ground Facilities

- Evaluate property reservation for non-aeronautical facilities.

Access, Circulation, and Truck Routes

- Maintain airport access to North Hargis Road following its realignment.
- Evaluate vehicle access points, circulation routes, and parking facilities in conjunction with the terminal building reconstruction.
- Monitor for capacity improvements on West Airport Road east of the intersection with the relocated North Hargis Road.

Perimeter Security

- Program for additional cameras, automated gates, and a continuous perimeter road.

APPENDIX FOUR. Runway Length Analysis

The runway length analysis recommends the length necessary to meet existing and future aircraft demands. The determination of runway recommendation for airport planning purposes uses the methodology found in FAA AC 150/5325-4B, *Runway Length Requirements for Airport Design*. This AC states the design objective for primary runways is to provide a runway length for all aircraft that will regularly use the runway without causing operational weight restrictions. AC 150/5000-17, *Critical Aircraft and Regular Use Determination* defines regular use as 500 annual operations, excluding touch-and-go local operations.

RUNWAY LENGTH METHODOLOGY

FAA AC 150/5325-4B describes five steps to determine recommended runway lengths. The information from these steps is to be used for airport design and not for flight operations. The five steps are:

1. Identify potential design aircraft
2. Identify the most demand aircraft
3. Determine appropriate methodology
4. Determine the recommended runway length
5. Apply necessary adjustments as needed.

Design Aircraft and Most Demanding Aircraft

The existing design aircraft (and most demanding aircraft) for Runway 17/35 has been determined to be the Embraer ERJ 145. The future design aircraft (and most demanding aircraft) is the Embraer ERJ 175.

The existing and future design aircraft (and most demanding aircraft) for Runway 4/22 has been determined to be the family grouping of small aircraft (i.e., aircraft with maximum takeoff weight equal to or less than 12,500 pounds) that have approach speeds greater than 50 knots but have less than 10 passenger seats excluding crew (i.e., pilot and copilot) as defined by AC 150/5325-4B. This family grouping of small aircraft is further divided into two categories according to percentage of fleet: 95 percent and 100 percent. The differences between the two percentage categories are based on the airport's location and amount of existing or planned aviation activities.

The 95 percent of the fleet category is intended to serve medium size population communities with a diversity of usage and a greater potential for increased aviation activities. It also includes those airports that are primarily intended to service low-activity locations, small population communities, and remote recreational areas. The 100 percent of the fleet category is intended to serve communities located on the fringe of a metropolitan area or a relatively large population remote from a metropolitan area. Stillwater and aircraft activity at SWO are best represented by the 95 percent category.

Determine Appropriate Methodology

Following guidance provided in AC 150/5325-4B, individual Airport Planning Manuals (APMs) produced and published by aircraft manufacturers should be used for regional jets or aircraft with Maximum Takeoff Weight (MTOW) greater than 60,000 pounds. Therefore, the APMs for the ERJ 145 and ERJ 175 will be used to determine a recommended length for Runway 17/35; the family grouping of small aircraft will be used to determine a recommended length for Runway 4/22.

The performance requirements of the design aircraft determine recommended runway length. Factors that affect aircraft performance capabilities include the airport elevation, air temperature, aircraft payload, fuel load, and wind conditions. These factors are explained below.

Elevation

Aircraft performance declines at higher altitudes because the air is less dense. Higher elevations negatively impact thrust produced by the aircraft on takeoff and the aerodynamic performance of the aircraft. An elevation of 1,000 feet above mean sea level (AMSL) is used for this analysis.

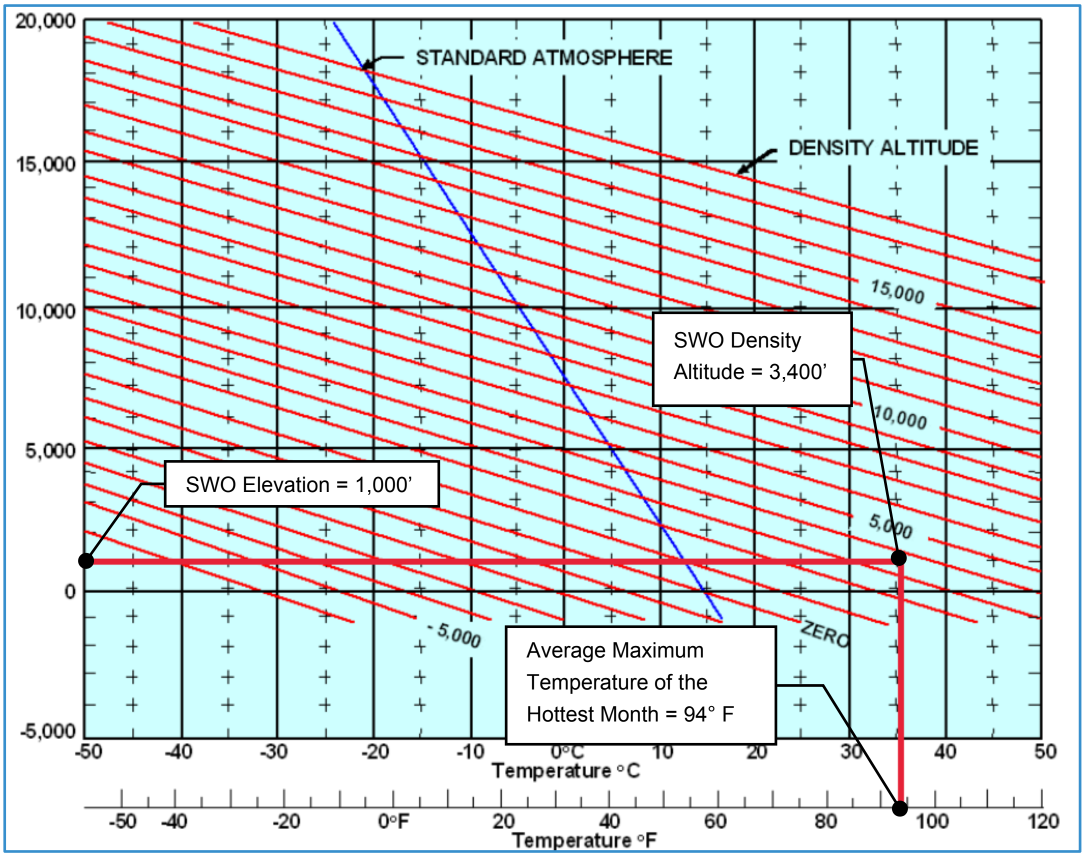
International Standard Atmosphere (ISA)

International Standard Atmosphere (ISA) is a mathematical model that describes how the earth's atmosphere, or air pressure and density, changes relative to altitude. The atmosphere is less dense at higher elevations. ISA is frequently used in aircraft performance calculations because conditions that deviate from ISA will affect aircraft performance. ISA at sea level occurs when the temperature is 59 degrees Fahrenheit. According to the 1976 Standard Atmosphere Calculator, the ISA at SWO's 1,000 feet AMSL occurs when the temperature is 55 degrees Fahrenheit.

Density Altitude (DA)

Density Altitude (DA) compares air density to ISA at a point in time and specific location and is also a critical component of aircraft performance calculations. DA is used to describe how aircraft performance differs from the performance that would be expected under ISA. DA is primarily influenced by elevation and air temperature. **Figure 4-1** Error! Reference source not found.illustrates how DA is impacted when factoring in the average maximum temperature of the hottest month. The SWO DA during the hottest month, when the ambient air temperature is 94 degrees Fahrenheit, is 3,400 feet AMSL. As a measure of high temperature impacts on aircraft performance, this DA is used in aircraft performance assessment.

Figure 4-1: Density Altitude for SWO



Takeoff Weight and Destination

Aircraft takeoff weight is directly related to the distance of the flight and the load that the aircraft is carrying. For shorter distances, aircraft may depart with a full passenger load and less than full fuel tanks. In those instances, the aircraft will typically be departing below MTOW and will not require as long of a runway. Aircraft require more fuel for longer trips, and the longest trips may require payload restrictions on the passengers, baggage, and cargo that can be carried. An aircraft with full passenger load and fuel will be near its MTOW.

Currently, Envoy Airlines provides twice daily non-stop service to Dallas Fort Worth International Airport (DFW), which is approximately 200 nautical miles (NM) from Stillwater. Additional long-term potential destinations that could be served by commercial air carriers include Denver International Airport (DEN) and Chicago O'Hare International Airport (ORD), which are located approximately 225 NM and 550 NM from Stillwater, respectively.

Recommended Runway Length Determination

Runway 17/35

The runway 17/35 length analysis is based on the payload and range table and the takeoff performance charts in the APMs for the existing and future design aircraft. AC 150/5325-4B allows for runway length determination to be based on MTOW. As seen in **Figure 4-2**, the runway length for the E-145 at 48,502 pounds MTOW and at SWO's DA of 3,400 feet AMSL is approximately 8,200 feet (represented by the red dashed line). However, using SWO's existing runway length of 7,401 feet, the operational takeoff weight is approximately 46,200 pounds (represented by the solid red line), about 2,500 pounds less than its MTOW. It is understood that the ERJ 145s departing SWO currently fly to DFW, do not need full fuel capacity, and are not routinely carrying full passenger loads. In other words, the ERJ 145s are not required to takeoff at MTOW.

Figure 4-2: E-145 Takeoff Runway Length Requirements

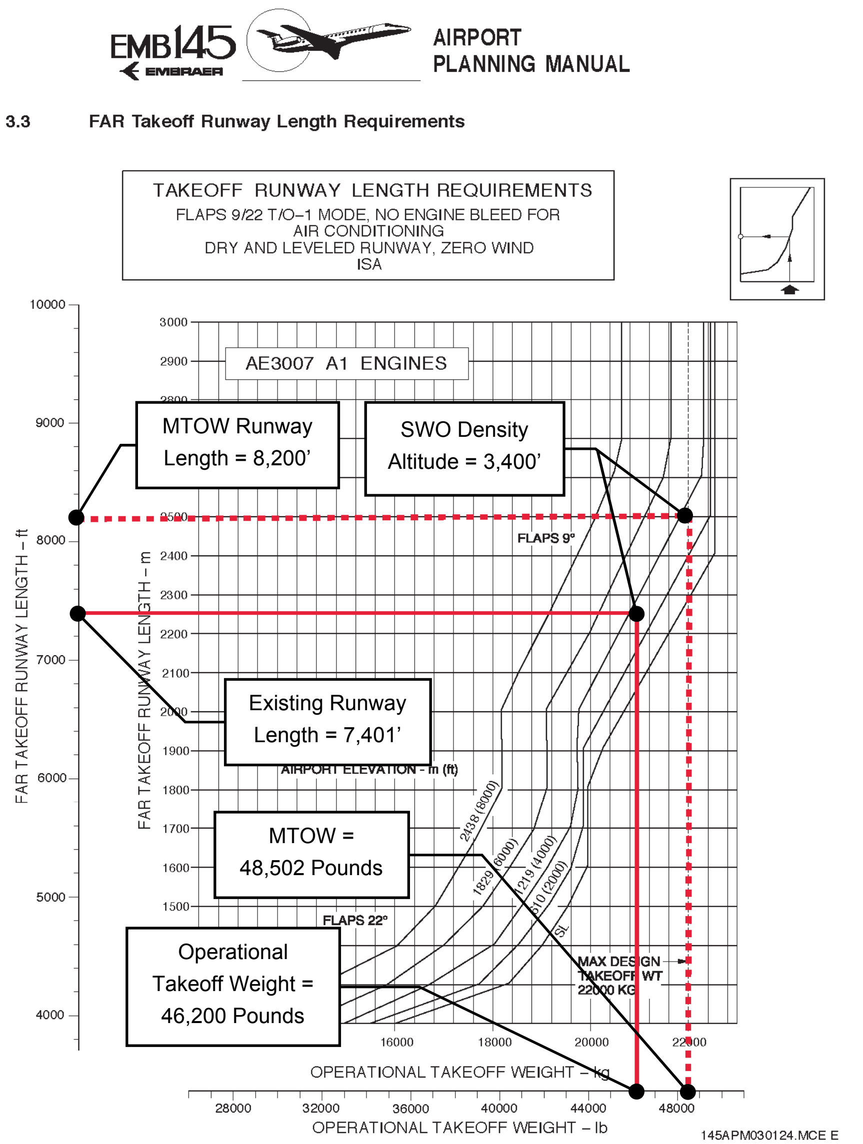


Figure 3.3.1 - FAR Takeoff Runway Length Requirements - ISA Conditions
Sheet 1

Source: Mead & Hunt analysis using Embraer E 145 Airport Planning Manual.

When using the payload versus range chart (see **Figure 4-3**), it is only when an approximate 650-NM range is required does the ERJ 145 begin to experience maximum payload restrictions. Since payload is a measure of passengers, baggage, and cargo (i.e., not including fuel), the MTOW reductions do not affect the future destinations most likely to be served by air carriers from SWO because the reduced weight can be met with less fuel and not fewer passengers. As detailed above, the most likely future destinations to be served from SWO are DEN and ORD, which are within the range of the maximum payload allowed.

Figure 4-3: E-145 Payload Versus Range

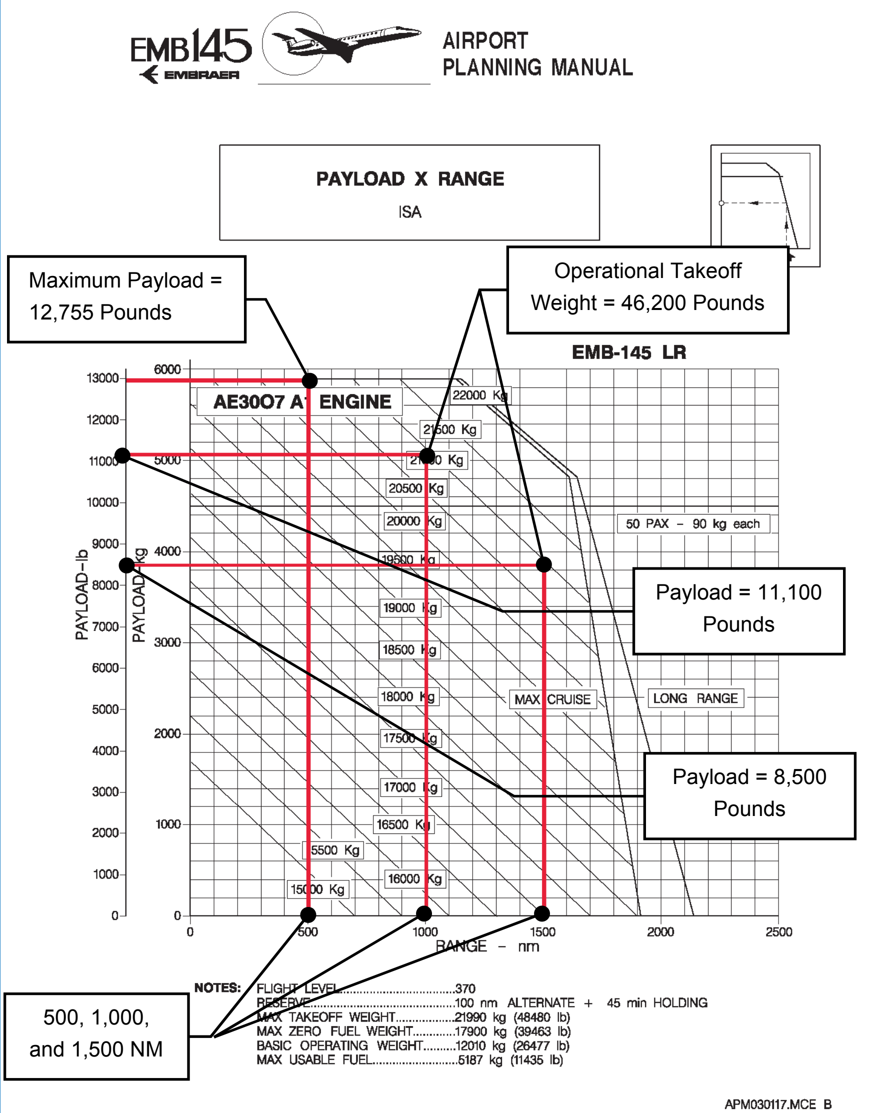


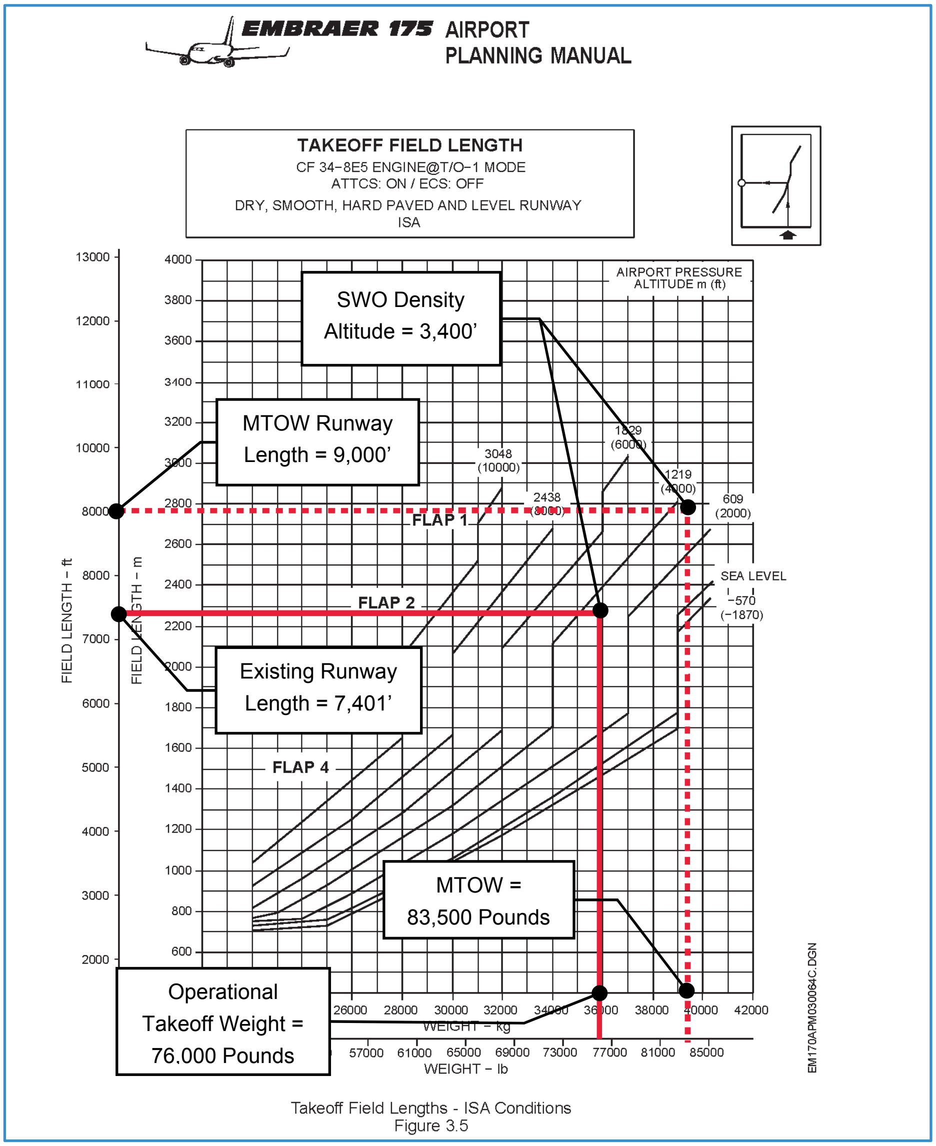
*Figure 3.2.1 - Payload x Range for Long Range Cruise at 37,000 ft, Engine with Thrust Reverser
Sheet 2*

Source: Mead & Hunt analysis using Embraer E 145 Airport Planning Manual.

Figure 4-4 presents the runway length requirements of the ERJ 175. The runway length required at the 83,500 MTOW and DA of 3,400 feet AMSL is approximately 9,000 feet. Using SWO's existing runway length of 7,401 feet indicates the operational takeoff weight is approximately 76,000 pounds, about 7,500 pounds less than MTOW. However, as with the ERJ 145s, it is not expected that ERJ 175s departing SWO will be required to operate at MTOW. This is verified by **Figure 4-5**, which indicates that not until an approximate

1,300-NM range is required does the E-175 experience maximum payload restrictions. The reduced MTOW can be met with less fuel and not fewer passengers.

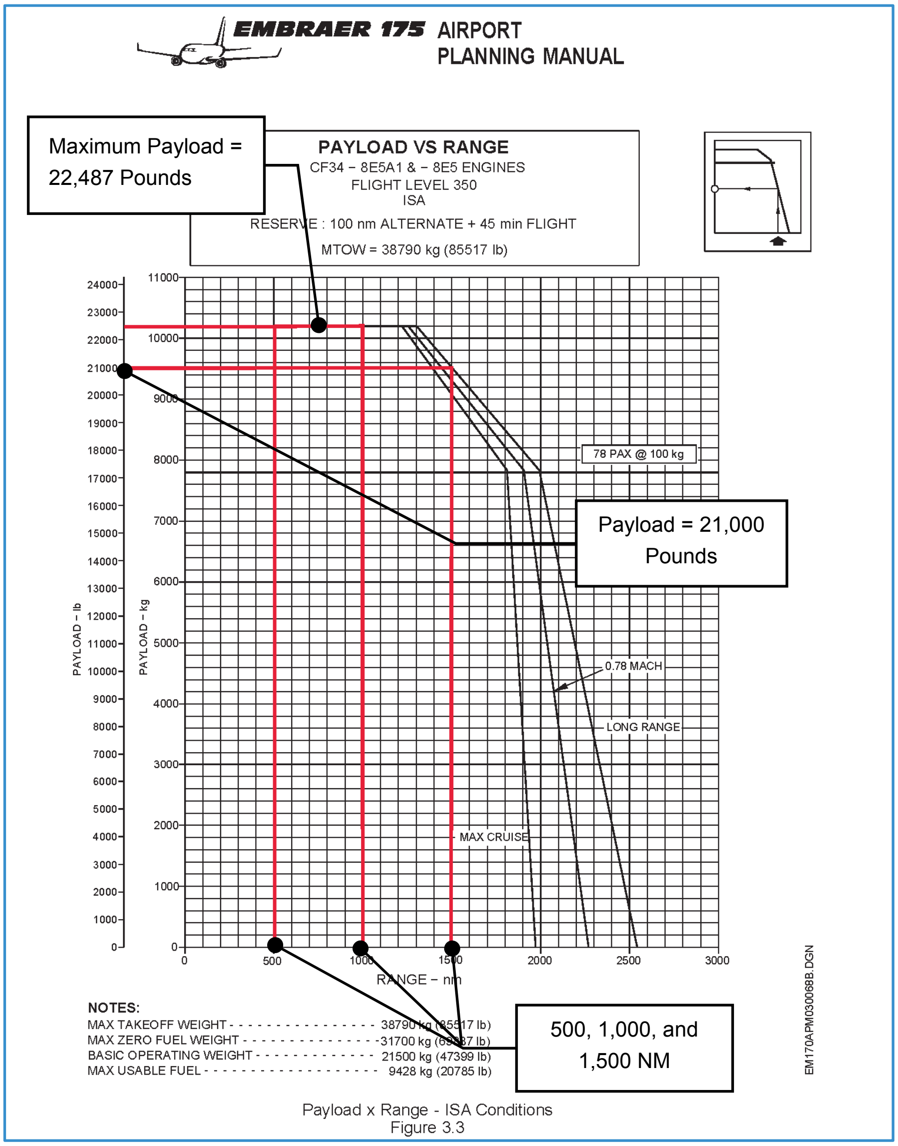
Figure 4-4: E-175 Takeoff Runway Length Requirements



Takeoff Field Lengths - ISA Conditions
Figure 3.5

Source: Mead & Hunt analysis Embraer E 175 Airport Planning Manual.
Note: There is a typo of 8,000 feet in field length rather than 9,000 feet.

Figure 4-5: E-175 Payload Versus Range



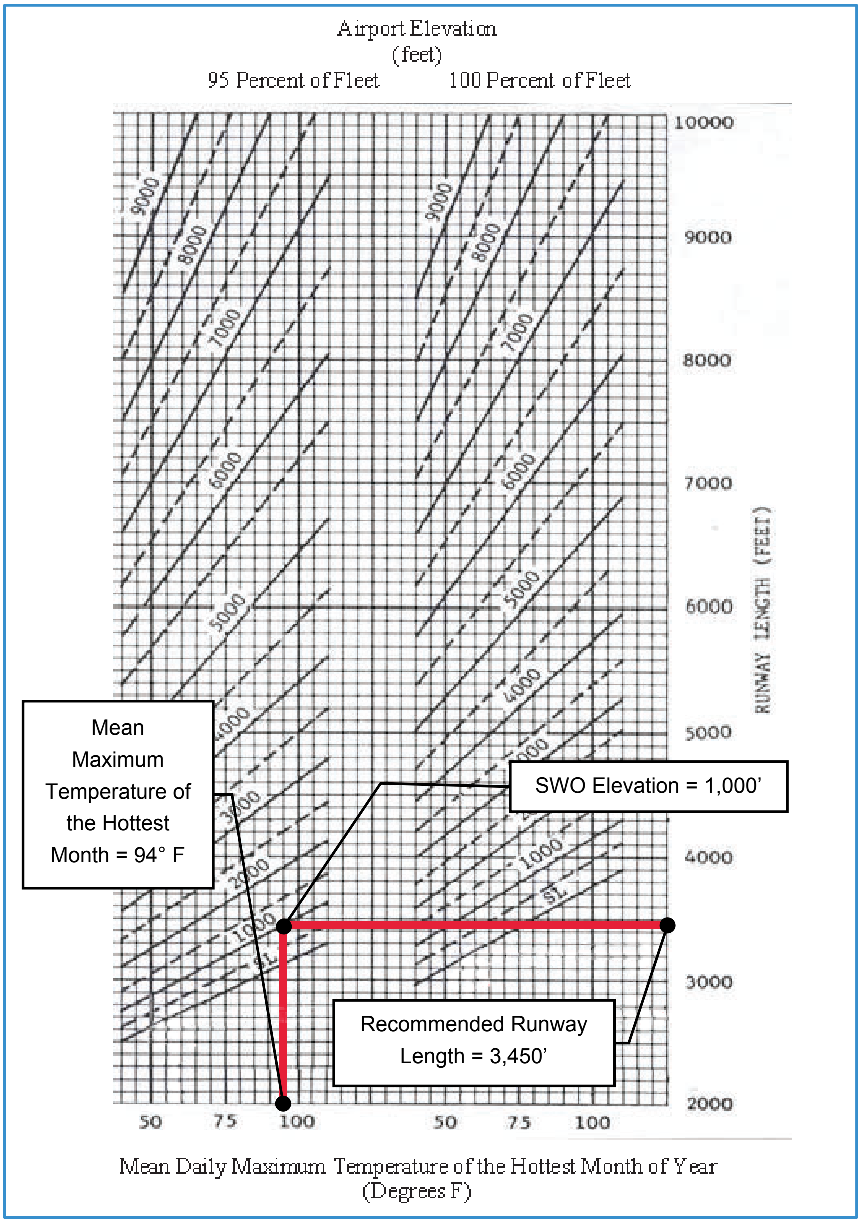
Payload x Range - ISA Conditions
Figure 3.3

Source: Mead & Hunt analysis using Embraer E 175 Airport Planning Manual.

Runway 4/22

Figure 4-6 uses the 95 percent of the small aircraft fleet with approach speeds greater than 50 knots and less than 10 passenger seats. Using SWO's elevation of 1,000 feet (not the DA of 3,400 feet) and the mean maximum temperature of the hottest month (94 degrees Fahrenheit), a runway length of approximately 3,450 feet is recommended as shown in the chart.

Figure 4-6: Small Aircraft with Less Than 10 Passenger Seats Takeoff Runway Length Requirements



Source: Mead & Hunt analysis using FAA AC 150/5325-4B, *Runway Length Requirements for Airport Design*.

Apply Necessary Adjustments

AC 150/5325-4B allows for the adjustment of runway lengths for non-zero effective runway gradients (i.e., runways having a difference in centerline elevation that is not equal to zero). The adjustment increases the takeoff length thy 10 feet for every 1-foot of maximum elevation difference of the runway centerline. For Runway 17/35 an adjustment of 430 feet is provided since the maximum centerline elevation difference is 43 feet. For Runway 4/22 an adjustment of 280 feet is afforded since the maximum centerline elevation difference is 28 feet.

Table 4-1 provides the recommended runway lengths after applying the adjustments.

Table 4-1: Runway Length Recommendations with Adjustments

Runway	Recommended Runway Length	Maximum Centerline Elevation Difference	Adjustment	Final Recommended Runway Length
17/35				**7,401**
Existing Design Aircraft (E-145)	8,200’ (MTOW)	43’	430’	8,630’
Future Design Aircraft (E-175)	9,000’ (MTOW)	43’	430’	9,430’
4/22				**5,004**
Existing and Future Design Aircraft (C 172)	3,450’	28’	280’	3,730’

Source: Mead & Hunt using airport planning manuals and FAA AC 150/5325-4B methodology.

RUNWAY LENGTH CONCLUSION

The runway length analysis suggests that Runway 17/35, with an existing length of 7,401 feet is slightly deficient to accommodate both the existing and future design aircraft when operating at MTOW. However, since the existing destination for Envoy Airlines aircraft is DFW and the most likely destinations for air carriers to provide long-term future service from SWO is DEN and ORD, which are within the ranges of both the ERJ 145 and 175 aircraft without requiring payload restrictions, this indicates that the Runway 17/35 length is sufficient, and no additional runway length is recommended. This is supported by the fact that no airport users have indicated runway length is insufficient for their operations and have not requested a runway extension.

APPENDIX FIVE. ATO and Ground Operations Analysis

Error! Not a valid bookmark self-reference. shows a detailed breakdown of the proposed Airline Ticket Offices (ATO) and ground operations areas.

Table 5-1: Airline Ticketing and Operations Office Space Program

Location	Quantity	Calculation	Notes
Airline Ticket Office			
Ticket Counters	3		Additional Counter
Counter Length w/ Bagwell	12’		
Counter Depth to Back Wall	12.5’		
Total Ticketing Area (sq ft)	150		
Station Manager (sq ft)	108		Enclosed Office
Supervisor's Office (sq ft)	90		
Agent Check-In/Cash-Out Workstations (sq ft)	70	2 x 35	Counters
Break & Conference Room (sq ft)	150		Kitchen Setup
Sub-Total ATO Space (sq ft)	568		
Airline Ground Operations Space (sq ft)			
Workstation Load & Balance	108		
MOD Desk	108		
Equipment Shelves – Radios/Chargers, Manuals	50	5 x 10	
Tow Bars	90	15 x 6	
Aircraft Maintenance Stores	100	10 x 10	
Lockers & Heavy Weather Gear Storage	100		Full Height Lockers
Sub-Total Operations Space	556		
Sub-Total ATO & Operations Space	1,124		
Circulation (10%)	112		Back of House
Total ATO & Ground Operations Space (sq ft)	**1,236**		
GSE Equipment Storage (sq ft)	**800**		**1 Tug and 1 Cart**
Grand Total ATO and Ground Operations Space (sq ft)	**2,036**		

Source: Mead & Hunt analysis.