



## Chapter 3 Facility Requirements

Proper airport planning requires the translation of forecast aviation demand into the specific types and quantities of facilities that can adequately serve the identified demand. This chapter will analyze the existing capacities of facilities at Waupaca Municipal Airport (PCZ). The existing capacities will then be compared to the forecast activity levels prepared in Chapter Two to determine the adequacy of the existing facilities and identify whether deficiencies currently exist or may be expected to materialize in the future. This chapter will present the following elements:

- Planning Horizon Activity Levels
- Airfield Capacity
- Airport Physical Planning Criteria
- Airside and Landside Facility Requirements

This exercise is intended to identify the adequacy of existing airport facilities, outline what new facilities may be needed, and determine when new facilities may be needed to accommodate forecasted demand. Once the facility needs have been identified, various alternatives for providing these facilities will be detailed for both the airside and the landside. Each alternative will be evaluated to determine the most feasible, cost-effective, and efficient means for implementation.

The facility requirements for Waupaca Municipal Airport were evaluated using guidance contained in several Federal Aviation Administration (FAA) publications, including the following:

- FAA Advisory Circular (AC) 150/5300-13B, *Airport Design*, Change 1
- AC 150/5060-5, *Airport Capacity and Delay*
- AC 150/5325-4B, *Runway Length Requirements for Airport Design*
- Federal Aviation Regulation (FAR) Part 77, *Objects Affecting Navigable Airspace*
- FAA Order 5090.5, *Formulation of the National Plan of Integrated Airport Systems (NPIAS) and the Airports Capital Improvement Plan (ACIP)*



**DEMAND-BASED PLANNING HORIZONS**

An updated set of aviation demand forecasts for Waupaca Municipal Airport was established and detailed in Chapter Two. These activity forecasts include annual aircraft operations, based aircraft, aircraft fleet mix, and peaking characteristics. With this information, specific components of the airfield and landside system can be evaluated to determine their capacity to accommodate future demand.

Cost-effective, efficient, and orderly development of an airport should be based more on actual demand at an airport than on a time-based forecast figure. To develop a master plan that is demand-based, rather than time-based, a series of planning horizon milestones has been established that takes into consideration the reasonable range of aviation demand projections. The planning horizons are the short term (years 1-5), the intermediate term (years 6-10), and the long term (years 11-20).

It is important to consider that the actual activity at the airport may be higher or lower than what the annualized forecast portrays. By planning according to activity milestones, the resultant plan can accommodate unexpected shifts or changes in the area’s aviation demand by allowing airport management the flexibility to make decisions and develop facilities based on need generated by actual demand levels, rather than dates in time. The demand-based schedule provides flexibility in development, as development schedules can be slowed or expedited according to demand at any given time over the planning period. The resultant plan provides airport officials with a financially responsible and needs-based program. **Table 3A** presents the short-, intermediate-, and long-term planning horizon milestones for each aircraft activity level forecasted in Chapter Two.

**TABLE 3A | Aviation Demand Planning Horizons**

	Base Year (2024)	Short Term (1-5 Years)	Intermediate Term (6-10 Years)	Long Term (11-20 Years)
<b>BASED AIRCRAFT</b>				
Single-Engine	43	46	48	54
Multi-Engine	4	4	3	3
Turboprop	0	1	2	3
Jet	2	2	3	4
Helicopter	0	0	1	2
<b>TOTAL BASED AIRCRAFT</b>	<b>49</b>	<b>53</b>	<b>57</b>	<b>66</b>
<b>ANNUAL OPERATIONS</b>				
<b>Itinerant</b>				
Air Carrier	0	0	0	0
Air Taxi	18	25	35	70
General Aviation	9,007	9,780	10,210	11,100
<b>Total Itinerant</b>	<b>9,025</b>	<b>9,805</b>	<b>10,245</b>	<b>11,170</b>
<b>Local</b>				
General Aviation	9,007	9,820	10,390	11,600
Local Military	10	10	10	10
<b>Total Local</b>	<b>9,017</b>	<b>9,830</b>	<b>10,400</b>	<b>11,610</b>
<b>TOTAL ANNUAL OPERATIONS</b>	<b>18,042</b>	<b>19,635</b>	<b>20,645</b>	<b>22,780</b>

Source: Coffman Associates analysis



### **AIRFIELD CAPACITY**

An airfield's capacity is expressed in terms of its annual service volume (ASV). ASV is a reasonable estimate of the maximum number of aircraft operations that can be accommodated in a year without incurring significant delay factors. As aircraft operations near or surpass the ASV, delay factors increase.

PCZ's ASV was examined using FAA AC 150/5060-5, *Airport Capacity and Delay*. Several factors were evaluated to calculate the airport's ASV, including the following:

- Runway configuration
- Runway use
- Exit taxiways
- Weather conditions
- Aircraft mix
- Percent arrivals
- Touch-and-go activity
- Peak period operations

Each factor represents an airfield or operational element that can contribute to delay. When these elements are examined together, the ASV at Waupaca Municipal Airport is approximately 230,000 annual operations. The ASV does not indicate a point of absolute gridlock but does represent a point at which delay for each operation increases exponentially and capacity becomes constrained.

Current operational estimates for PCZ represent approximately eight percent of the airfield's ASV. By the end of the long-term planning period, total annual operations are expected to represent approximately 10 percent of the airfield's ASV. FAA guidance recommends that improvements for airfield capacity purposes should begin to be considered once operations reach 60 to 75 percent of the ASV. At the 80 percent level, planned improvements should be made. Because existing and forecast operations remain well below these levels, no significant capacity improvements are planned; however, other options to improve airfield efficiency, such as taxiway geometry improvements, will still be considered.

### **AIRSIDE FACILITY REQUIREMENTS**

Airside facilities include those facilities related to the arrival, departure, and ground movement of aircraft. Airside facility requirements are based primarily on the runway design code (RDC) for each runway. Analysis in Chapter Two identified the existing RDC for Runway 10-28 as B-II-4000 and the ultimate RDC as C-II-4000. For Runway 13-31, the existing and ultimate RDC is B-I(S)-VIS.

### **RUNWAYS**

Runway conditions, such as orientation, length, width, and pavement strength, were analyzed at Waupaca Municipal Airport. From this information, requirements for runway improvements were determined for the airport.



### Runway Orientation

Key considerations in the runway configuration of an airport involve the orientation for wind coverage and the operational capacity of the runway system. FAA AC 150/5300-13B, *Airport Design*, Change 1, recommends that a crosswind runway be made available when the primary runway orientation provides less than 95 percent crosswind component coverage for an aircraft design group. **Table 3B** details the allowable crosswind component for each RDC.

**TABLE 3B | Allowable Crosswind Component by RDC**

RDC	Allowable Crosswind Component
A-I and B-I (includes small aircraft)	10.5 knots
A-II and B-II	13 knots
A-III and B-III	16 knots
C-I through D-III	16 knots
A-IV and B-IV	20 knots
C-IV through C-VI	20 knots
D-IV through D-VI	20 knots
E-I through E-VI	20 knots

*Source: FAA AC 150/5300-13B, Airport Design, Change 1*

**Exhibit 3A** presents the generalized, FAA-accepted all-weather and instrument flight rules (IFR) wind roses for the airport. The previous 10 years of wind data<sup>1</sup> were obtained from the on-airport automated weather observation station (AWOS) and have been analyzed to identify the wind coverage provided by the existing runway orientations. At Waupaca Municipal Airport, the orientation of Runway 10-28 provides 97.21 percent coverage for the 10.5-knot component and greater than 98 percent coverage for 13-, 16-, and 20-knot components in all weather conditions. Runway 13-31 provides 96.49 percent coverage for the 10.5 knot component and greater than 98 percent coverage for the 13-, 16-, and 20-knot components. Combined, the runways provide 98.31 percent coverage in all other weather conditions. In IFR conditions, the individual and combined runways provide greater than 97.00 percent coverage for each crosswind component. **It should be noted that the calculations described above exclude gusting conditions, which the FAA does not consider when determining runway orientation. Gusting conditions, specifically wind gust velocities, affect what runway a pilot chooses to use; however, the FAA does not support using gusts to determine crosswind runway eligibility or justification.**

### Summary

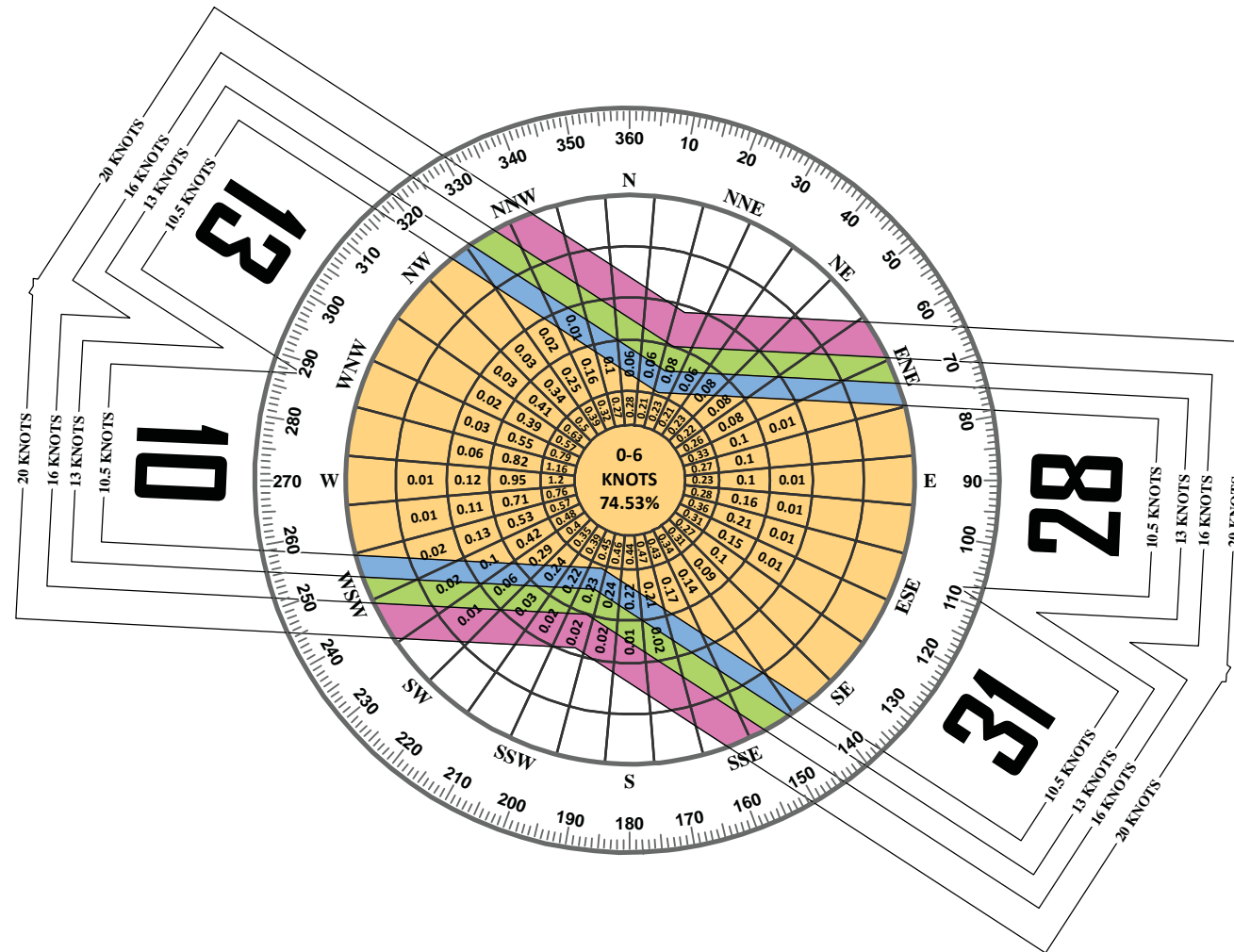
Runway 10-28 is currently classified as a B-II runway with forecasted potential to become a C-II runway when operations dictate (i.e., when at least 500 annual operations by aircraft within the C-II family are documented). Runway 13-31 is classified as a B-I(S) runway in the existing and ultimate conditions. As detailed in **Table 3B**, the allowable crosswind component for a B-II runway is 13 knots and 10.5 knots for B-I(S) runways; however, given that the crosswind component for Runway 10-28 is greater than 95 percent at 10.5 knots, Runway 13-31 is currently ineligible for federal funding assistance through the

<sup>1</sup> NOAA, National Climatic Data Center, Asheville, North Carolina, for Waupaca Municipal Airport, Waupaca, WI



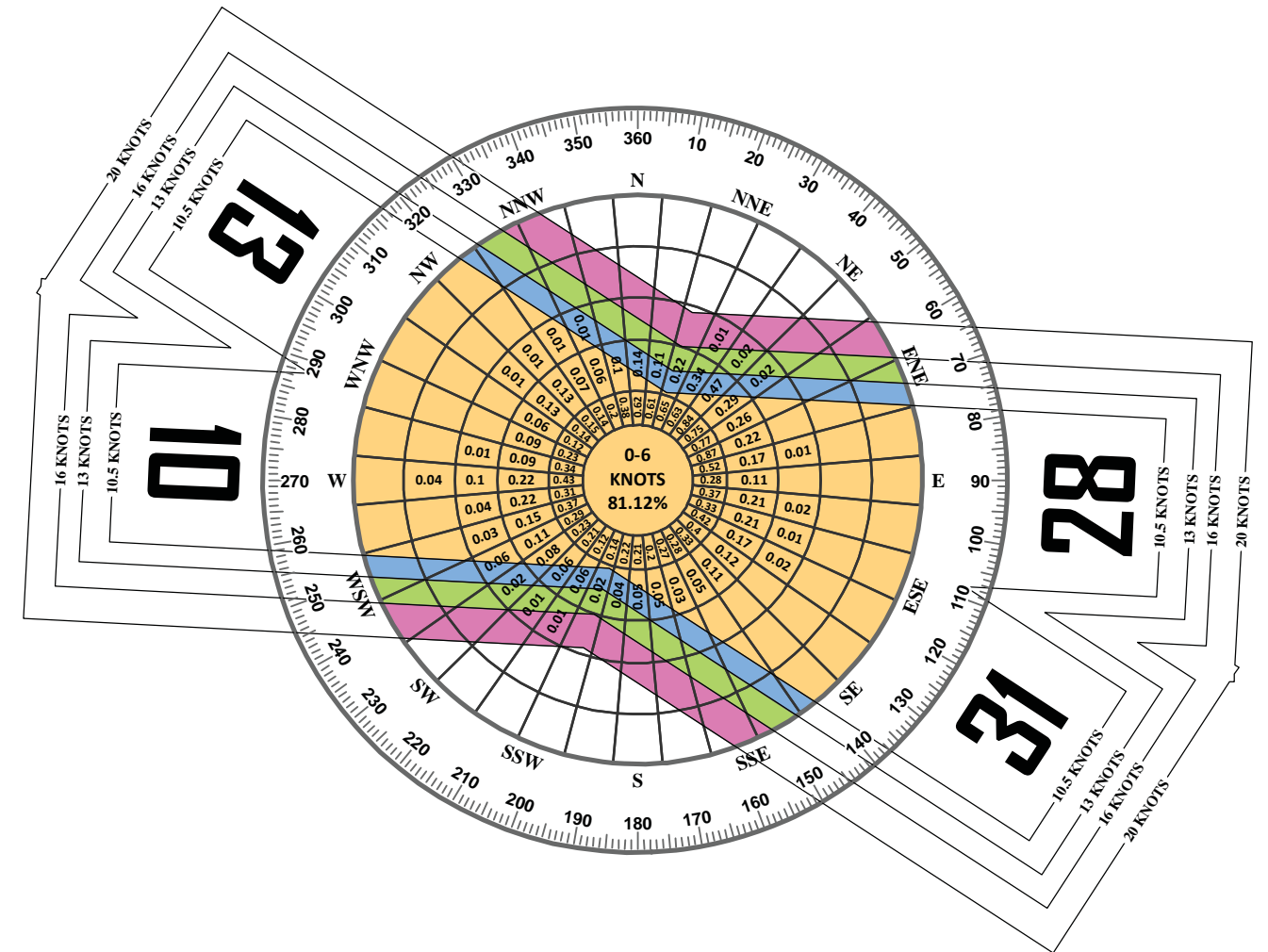
ALL WEATHER WIND COVERAGE				
Runways	10.5 Knots	13 Knots	16 Knots	20 Knots
Runway 10-28	97.21%	98.68%	99.79%	99.97%
Runway 13-31	96.49%	98.25%	99.57%	99.91%
All Runways	98.31%	99.32%	99.90%	99.99%

IFR WIND COVERAGE				
Runways	10.5 Knots	13 Knots	16 Knots	20 Knots
Runway 10-28	98.12%	99.20%	99.91%	99.99%
Runway 13-31	97.20%	98.55%	99.75%	99.97%
All Runways	98.58%	99.50%	99.96%	99.99%



SOURCE:  
 NOAA National Climatic Center  
 Asheville, North Carolina  
 Waupaca Municipal Airport  
 Waupaca, WI

OBSERVATIONS:  
 252,706 All Weather Observations  
 Jan. 1, 2014 - Dec. 31 2023



SOURCE:  
 NOAA National Climatic Center  
 Asheville, North Carolina  
 Waupaca Municipal Airport  
 Waupaca, WI

OBSERVATIONS:  
 24,062 IFR Observations  
 Jan. 1, 2014 - Dec. 31 2023

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Wisconsin Department of Transportation (WisDOT) Bureau of Aeronautics (BOA). As such, funding to maintain Runway 13-31 will remain the responsibility of the City of Waupaca. Should local demands dictate, it is prudent to continue to maintain the current crosswind runway designed to meet A/B-I(S) aircraft operations at Waupaca Municipal Airport. Alternative considerations (to be discussed in the next chapter) will explore options for the ultimate disposition of Runway 13-31.

### Runway Designations

A runway's designation is based on its magnetic headings, which are determined by the magnetic declination for the area. The runway has a true heading of 093°/273°. Adjusting for the magnetic declination, the current magnetic heading of Runway 10-28 is 094°/274°. The true heading of Runway 13-31 is 123°/303° and its magnetic heading is 124°/304°. The runway designations will not need to change for the next 10 years.

### Runway Length

AC 150/5325-4B, *Runway Length Requirements for Airport Design*, provides guidance for determining runway length needs. The determination of runway length requirements for the airport is based on five primary factors:

- Mean maximum temperature of the hottest month
- Airport elevation
- Runway gradient
- Critical aircraft type expected to use the runway
- Stage length of the longest nonstop destination (specific to larger aircraft)

The mean maximum daily temperature of the hottest month for Waupaca Municipal Airport is 82 degrees Fahrenheit (°F), which occurs in July. The airport elevation is 840.2 feet mean sea level (MSL). Runway 10-28 has a longitudinal gradient of 0.67 percent, while Runway 13-31 has a gradient of 0.61 percent. Both conform to FAA design standards for the gradient.

Airplanes operate on a wide variety of available runway lengths. Many factors govern the sustainability of runway lengths for aircraft, such as elevation, temperature, wind, aircraft weight, wing flap settings, runway condition (wet or dry), runway gradient, vicinity airspace obstructions, and any special operating procedures. Airport operators can pursue policies that maximize the sustainability of the runway length. Policies such as area zoning and height and hazard restrictions can protect an airport's runway length. Airport ownership (fee simple easement) of land leading to the runway ends reduces the possibility of natural growth or human-made obstructions. Planning for runways should include an evaluation of the aircraft types expected to use the airport now and in the future. Future planning should be realistic, supported by the FAA-approved forecasts, and based on the critical aircraft (or family of aircraft).



**General Aviation Aircraft**

Most operations occurring at Waupaca Municipal Airport are conducted using smaller general aviation (GA) aircraft that weigh less than 12,500 pounds. Following guidance from AC 150/ 5325-4B, to accommodate 95 percent of these small aircraft with fewer than 10 passenger seats, a runway length of 3,300 feet is recommended. For 100 percent of these small aircraft, a runway length of 3,900 feet is recommended. For small aircraft with 10 or more passenger seats, a runway length of 4,200 feet is recommended.

The airport is also utilized by aircraft that weigh more than 12,500 pounds, including small- to medium-sized business jet aircraft. Runway length requirements for business jets that weigh less than 60,000 pounds have also been calculated. These calculations take into consideration the runway gradient and landing length requirements for contaminated (wet) runways. Business jets tend to need greater runway length when landing on wet surfaces because of their increased approach speeds. AC 150/5325-4B stipulates that runway length determination for business jets must consider a grouping of airplanes with similar operating characteristics. The AC provides two separate family groupings of airplanes, each of which is based on its representative percentage of aircraft in the national fleet. The first grouping is those business jets that comprise 75 percent of the national fleet, and the second grouping is those that comprise 100 percent of the national fleet. **Table 3C** presents a partial list of common aircraft in each aircraft grouping. A third grouping considers business jets that weigh more than 60,000 pounds. Runway length determination for these aircraft must be based on the performance characteristics of the individual aircraft.

**TABLE 3C | Business Jet Categories for Runway Length Determination**

Aircraft	MTOW (lbs.)
<b>75 Percent of the National Fleet</b>	
Lear 35	20,350
Lear 45	20,500
Cessna 550	14,100
Cessna 560XL	20,000
Cessna 650 (VII)	22,000
IAI Westwind	23,500
Beechjet 400	15,800
Falcon 50	18,500
<b>75-100 Percent of the National Fleet</b>	
Lear 55	21,500
Lear 60	23,500
Hawker 800XP	28,000
Hawker 1000	31,000
Cessna 650 (III/IV)	22,000
Cessna 750 (X)	36,100
Challenger 604	47,600
IAI Astra	23,500
<b>Greater than 60,000 Pounds</b>	
Gulfstream II	65,500
Gulfstream IV	73,200
Gulfstream V	90,500
Global Express	98,000
Gulfstream 650	99,600

MTOW = maximum takeoff weight

Source: FAA AC 150/5325-4B, Runway Length Requirements for Airport Design



Table 3D presents the results of the runway length analysis for business jets that was developed following the guidance provided in AC 150/5325-4B. To accommodate 75 percent of the business jet fleet at 60 percent useful load, a runway length of 5,400 feet is recommended. This length is derived from a raw length of 4,695 feet which is adjusted, as recommended, for runway gradient and consideration of landing length needs on a contaminated (wet and slippery) runway. To accommodate 100 percent of the business jet fleet at 60 percent useful load, 5,700 feet is the recommended runway length.

TABLE 3D | Runway Length Requirements

Fleet Mix Category	TAKEOFF LENGTHS		LANDING LENGTHS	Final Runway Length
	Raw Runway Length from FAA AC	Runway Length with Gradient Adjustment (+348')	Wet Surface Landing Length for Jets (+15%)*	
75% of Fleet at 60% Useful Load	4,695	5,043	5,399	5,400
100% of Fleet at 60% Useful Load	5,349	5,697	5,500	5,700
75% of Fleet at 90% Useful Load	6,258	6,606	7,000	7,000
100% of Fleet at 90% Useful Load	7,937	8,285	7,000	8,300

\*Max. 5,500' for 60% useful load and max. 7,000' for 90% useful load in wet condition

Source: FAA AC 150/5325-4B, Runway Length Requirements for Airport Design

Utilization of the 90 percent category for runway length determination is generally not considered by the FAA unless there is a demonstrated need at an airport, such as documented activity by a business jet operator that flies out frequently with heavy loads. To accommodate 75 percent of the business jet fleet at 90 percent useful load, a runway length of 7,000 feet is recommended. To accommodate 100 percent of business jets at 90 percent useful load, a runway length of 8,300 feet is recommended.

Another method to determine runway length requirements for aircraft at Waupaca Municipal Airport is to examine aircraft flight planning manuals under conditions specific to the airport. Several aircraft were analyzed for takeoff length requirements at a design temperature of 82.0°F and a field elevation of 840.2 feet MSL with a 0.67 percent runway grade. Table 3E provides a detailed runway length analysis for some of the most common turbine aircraft in the national fleet. These data were obtained from UltrNAV software, which computes operational parameters for specific aircraft based on flight manual data. The analysis includes the maximum takeoff weight (MTOW) allowable and the percent useful load from 60 percent to 100 percent.



TABLE 3E | Business Aircraft Takeoff Length Requirements – Runway 10-28

Aircraft Name	MTOW	TAKEOFF LENGTH REQUIREMENTS (feet)				
		Useful Load				
		60%	70%	80%	90%	100%
Pilatus PC-12	9,921	2,070	2,237	2,412	2,595	2,786
Citation I/SP	11,850	2,791	3,028	3,279	3,545	3,826
Citation CJ3	13,870	2,999	3,163	3,337	3,634	3,920
King Air 350	15,000	3,343	3,479	3,616	3,857	4,223
Citation Mustang	8,645	2,952	3,174	3,446	3,863	4,320
Citation (525A) CJ2	12,375	3,225	3,459	3,733	4,020	4,326
Citation Sovereign	30,300	3,743	3,768	3,832	4,075	4,376
Citation 560 XLS	20,200	3,396	3,661	3,944	4,219	4,547
Citation (525) CJ1	10,600	3,477	4,030	4,736	5,551	6,374
Challenger 300	38,850	4,537	4,971	5,420	5,881	6,369
Gulfstream 100	24,650	4,697	5,199	5,751	6,302	6,850
Gulfstream 150	26,100	4,897	5,199	5,751	6,302	6,850
Falcon 2000	35,800	4,726	5,261	5,960	6,770	7,627

Note: Green cell values are less than or equal to the length of the primary runway at Waupaca Municipal Airport; orange cell values are greater than the length of the primary runway at Waupaca Municipal Airport.  
 MTOW = maximum takeoff weight  
 Source: UltrNAV software

All of the aircraft analyzed are capable of departing at MTOW on the existing runway length during hot weather with useful loads at 60 percent, and the majority can operate with loads up to 70 percent. Beyond that, the fleet mix analyzed becomes more weight-restricted or (in some cases) unable to take off at loads exceeding 80 percent.

The Challenger 300 has a MTOW of 38,850. As the ultimate critical aircraft for Runway 10-28, its takeoff field length is 6,369 feet at 100 percent useful load. It is possible that extensions to Runway 10-28 may be required for this aircraft to be able to take off at 100 percent load.

**Table 3F** presents the runway length required for landing under three operational categories: Title 14 Code of Federal Regulations (CFR) Part 25, CFR Part 135, and CFR Part 91k. CFR Part 25 operations are those conducted by individuals or companies that own their aircraft. CFR Part 135 applies to all for-hire charter operations, including most fractional ownership operations. CFR Part 91k includes operations in fractional ownership that utilize their own aircraft under the direction of pilots specifically assigned to said aircraft. Part 91k and Part 135 rules regarding landing operations require operators to land at a destination airport within 60 percent of the effective runway length. An additional rule allows operators to land within 80 percent of the effective runway length if the operator has an approved destination airport analysis in the airport’s program operating manual. The landing length analysis accounts for both scenarios.



TABLE 3F | Business Aircraft Landing Length Requirements – Runway 10-28

Aircraft Name	MLW	LANDING LENGTH REQUIREMENTS (feet)					
		Dry Runway Condition			Wet Runway Condition		
		Part 25	80% Rule	60% Rule	Part 25	80% Rule	60% Rule
Pilatus PC-12	9,921	2,347	2,934	3,912	No Data	No Data	No Data
Citation I/SP	11,850	2,436	3,045	4,060	2,801	3,501	4,668
Falcon 2000	35,800	3,178	3,973	5,297	3,655	4,569	6,092
Citation Mustang	8,645	2,807	3,509	4,678	3,961	4,951	6,602
Challenger 300	33,750	2,648	5,076	4,413	8,460	3,310	6,345
Citation Sovereign	30,300	3,195	3,994	5,325	4,142	5,178	6,903
Citation (525) CJ1	10,600	3,255	4,069	5,425	4,433	5,541	7,388
Citation CJ3	13,870	3,351	4,189	5,585	4,573	5,716	7,622
Gulfstream 150	26,100	3,304	4,130	5,507	4,903	6,129	8,172
Citation (525A) CJ2	12,375	3,538	4,423	5,897	5,095	6,369	8,492
Citation 560 XLS	20,200	3,700	4,625	6,167	5,897	7,371	9,828
Gulfstream 100	24,650	3,375	4,219	5,625	6,191	7,739	10,318

Note: Green cell values are less than or equal to the length of the primary runway at Waupaca Municipal Airport; orange cell values are greater than the length of the primary runway at Waupaca Municipal Airport.  
 MLW = maximum landing weight  
 N/A = not applicable; some turboprop aircraft landing lengths are not adjusted for wet runway conditions

Source: UltrNAV software

The landing length analysis shows that, of the aircraft analyzed, all Part 25 and Part 91k operations can land on the available runway length at Waupaca Municipal Airport during dry runway conditions; however, fewer than half of the aircraft analyzed can conduct operations if operating under Part 135 during dry conditions. During wet (or contaminated) runway conditions, most of the analyzed aircraft can land when operating under Part 25, approximately half are able to operate under Part 91k, and very few are able to operate under Part 135.

*Runway Length Summary*

Many factors were considered when determining appropriate runway length for safe and efficient operations of aircraft at Waupaca Municipal Airport. The airport should strive to accommodate business jets and turboprop aircraft to the greatest extent possible, as demand dictates. Primary Runway 10-28 is currently 5,200 feet long and (as detailed in the tables above) can accommodate many of the common business jets operating at Waupaca Municipal Airport under moderate loading conditions.

Justification for any runway extension to meet the needs of turbine aircraft would require regular use (500 annual itinerant operations) by a representative aircraft or family of aircraft, which is the minimum threshold required to obtain FAA grant funding assistance. While the primary runway at PCZ currently exceeds the recommended length for all small aircraft, the runway length recommendation per FAA AC 150/5325-4B is 5,400 feet to accommodate at least 75 percent of the business jet fleet at 60 percent useful load. Moreover, roughly half of the turbine aircraft currently using and anticipated to use the runway at Waupaca Municipal Airport are unable to operate when taking on useful loads of 80 percent and greater, according to UltrNAV calculations. As such, runway extension options should be considered. The current critical aircraft (Citation XLS) and the future critical aircraft (Challenger 300) can operate under certain conditions. The Citation XLS is able to take off at 100 percent useful load on the current runway length, while the Challenger 300 requires a minimum runway length of 6,369 feet. Alternatives (to be discussed in the next chapter) will analyze multiple options for a future potential runway extension.



Runway 13-31 is currently 3,899 feet long. As detailed previously, guidance from AC 150/ 5325-4B recommends a length of 3,300 feet to accommodate 95 percent of small aircraft with fewer than 10 passenger seats, while a length of 3,900 feet is required to accommodate 100 percent of small aircraft with fewer than 10 passenger seats. Alternative considerations to be presented in the next chapter will examine options for Runway 13-31, depending on the ultimate disposition of the runway, given its funding eligibility.

### Runway Width

Runway width design standards are primarily based on the critical aircraft but can also be influenced by the visibility minimums of published instrument approach procedures. For primary Runway 10-28, existing RDC B-II-4000 design requires a runway width of 75 feet ultimate RDC C-II-4000 requires a runway width of 100 feet. The existing width of Runway 10-28 is 100 feet, which should be maintained. Runway 13-31 is currently 75 feet wide, which exceeds the B-I(S)-VIS standard of 60 feet. If Runway 13-31 is to remain operational in the future, it should be maintained at 60 feet wide.

### Pavement Strength

An important feature of airfield pavement is its ability to withstand repeated use by aircraft of varying weights. The current airport layout plan (ALP), which was approved in 2007, lists the strength rating for Runway 10-28 as 30,000 pounds for single wheel aircraft (S). Currently, there is no published runway strength rating for dual wheel aircraft (D). Runway 13-31 is reported to have a pavement strength of 13,000 pounds S.

The strength rating of a runway does not preclude aircraft that weigh more than the published strength rating from using the runway. All federally obligated airports must remain open to the public, and it is typically up to the pilot of an aircraft to determine if a runway can safely support the aircraft. An airport sponsor cannot restrict an aircraft from using the runway simply because its weight exceeds the published strength rating; however, the airport sponsor has an obligation to properly maintain and protect the useful life of the runway (typically for 20 years).

The strength rating of a runway can change over time. Regular usage by heavier aircraft can decrease the strength rating, while periodic runway resurfacing can increase the strength rating. The current runway strength rating on each runway is adequate to accommodate the aircraft that currently and are anticipated to operate at the airport. The ultimate critical aircraft, represented by the C-II-2A Challenger 300, can weigh over 38,000 pounds D; therefore, the pavement strength rating for Runway 10-28 should be maintained at 30,000 pounds S and increased to 60,000 pounds D in the ultimate condition. If Runway 13-31 is to be maintained, a runway strength rating of 12,500 pounds should be considered to accommodate B-I(S) aircraft.



### Runway Line-of-Sight and Gradient

The FAA has instituted various line-of-sight requirements to facilitate coordination among aircraft and between aircraft and vehicles that are operating on active runways. This allows departing and arriving aircraft to verify the locations and actions of other aircraft and vehicles on the ground that could create a conflict.

Line-of-sight standards for an individual runway are based on a parallel taxiway is available. When a partial parallel taxiway is available, any point five feet above the runway centerline must be mutually visible with any other point five feet above the runway centerline. Both runways at PCZ meet the line-of-sight standard.

The surface gradient of a runway affects aircraft performance and pilot perception. The surface gradient is the maximum allowable slope for a runway. For runways designated for approach categories A and B, the maximum longitudinal grade is 2.0 percent. Runway 10-28 has a longitudinal grade of 0.67 percent, while Runway 13-31 has a longitudinal grade of 0.61 percent. Both runways meet the gradient standard.

### SAFETY AREA DESIGN STANDARDS

The FAA has established several imaginary surfaces to protect aircraft operational areas and keep them free from obstructions. These include the runway safety area (RSA), runway object free area (ROFA), runway obstacle free zone (ROFZ), and runway protection zone (RPZ).

The entire RSA, ROFA, and ROFZ must be under the direct ownership of the airport sponsor to ensure these areas remain free of obstacles and can be readily accessed by maintenance and emergency personnel. RPZs should also be under airport ownership. An alternative to outright ownership of the RPZ is the purchase of aviation easements (acquiring control of designated airspace within the RPZ) or having sufficient land use control measures in place that ensure the RPZ remains free of incompatible development. The various airport safety areas and their dimensions, as sourced from FAA AC 150/5300-13B, *Airport Design*, Change 1, are presented graphically on **Exhibit 3B**.

### Runway Safety Area

The RSA is defined in FAA AC 150/5300-13B, *Airport Design*, Change 1, as a “defined area surrounding the runway consisting of a prepared surface suitable for reducing the risk of damage to aircraft in the event of undershoot, overshoot, or excursion from the runway.” The RSA is centered on the runway and dimensioned in accordance with the approach speed of the critical aircraft using the runway. The FAA requires the RSA to be cleared and graded, drained by grading or storm sewers, capable of accommodating the critical aircraft and fire and rescue vehicles, and free of obstacles that are not fixed by navigational purpose, such as runway edge lights or approach lights.

The FAA places high significance on maintaining adequate RSAs at all airports. The FAA established the *Runway Safety Area Program* under Order 5200.8 (effective October 1, 1999). The Order states: “The objective of the Runway Safety Area Program is that all RSAs at federally obligated airports...shall



conform to the standards contained in AC 150/5300-13B Change 1, *Airport Design*, to the extent practicable.” Each Regional Airports Division of the FAA is obligated to collect and maintain data on the RSAs for all runways and perform airport inspections.

As shown on **Exhibit 3B**, for existing RDC B-II-4000 design standards on primary Runway 10-28, the FAA calls for the RSA to be 150 feet wide and extend 300 feet beyond the runway ends. In the ultimate RDC C-II-4000 environment, the dimensions of the Runway 10-28 RSA increase to 500 feet wide and extend 1,000 feet beyond the end of the runway. For crosswind Runway 13-31 in both the existing and ultimate runway conditions, the RSA dimensions are 120 wide and extend 240 feet beyond the runway ends. For both runways, at the dimensions detailed above, the RSA is fully contained within airport property and free of obstructions under existing and ultimate conditions.

### **Overlapping Runway Safety Areas and Elevated Risk**

Runway configurations that result in a runway threshold being located in close proximity to another runway or runway threshold create an elevated risk for runway incursions and wrong surface events. A wrong surface event occurs when an aircraft lands or departs, or tries to land or depart, on the wrong runway or on a taxiway. The causal factors for such events are broad. As they relate to airport design, airfield pavement geometries may contribute to wrong surface events.

The current configuration of Runway 10-28 and 13-31 is subject to elevated risk, as the Runway 10 threshold is situated on Runway 13-31. This configuration does not provide sufficient physical space for designing entrance taxiways or associated markings and signage, thus increasing the potential for a runway incursion, pilot confusion, and loss of situational awareness. Alternatives presented in the next chapter will examine potential solutions to alleviate risks associated with the intersecting runways.

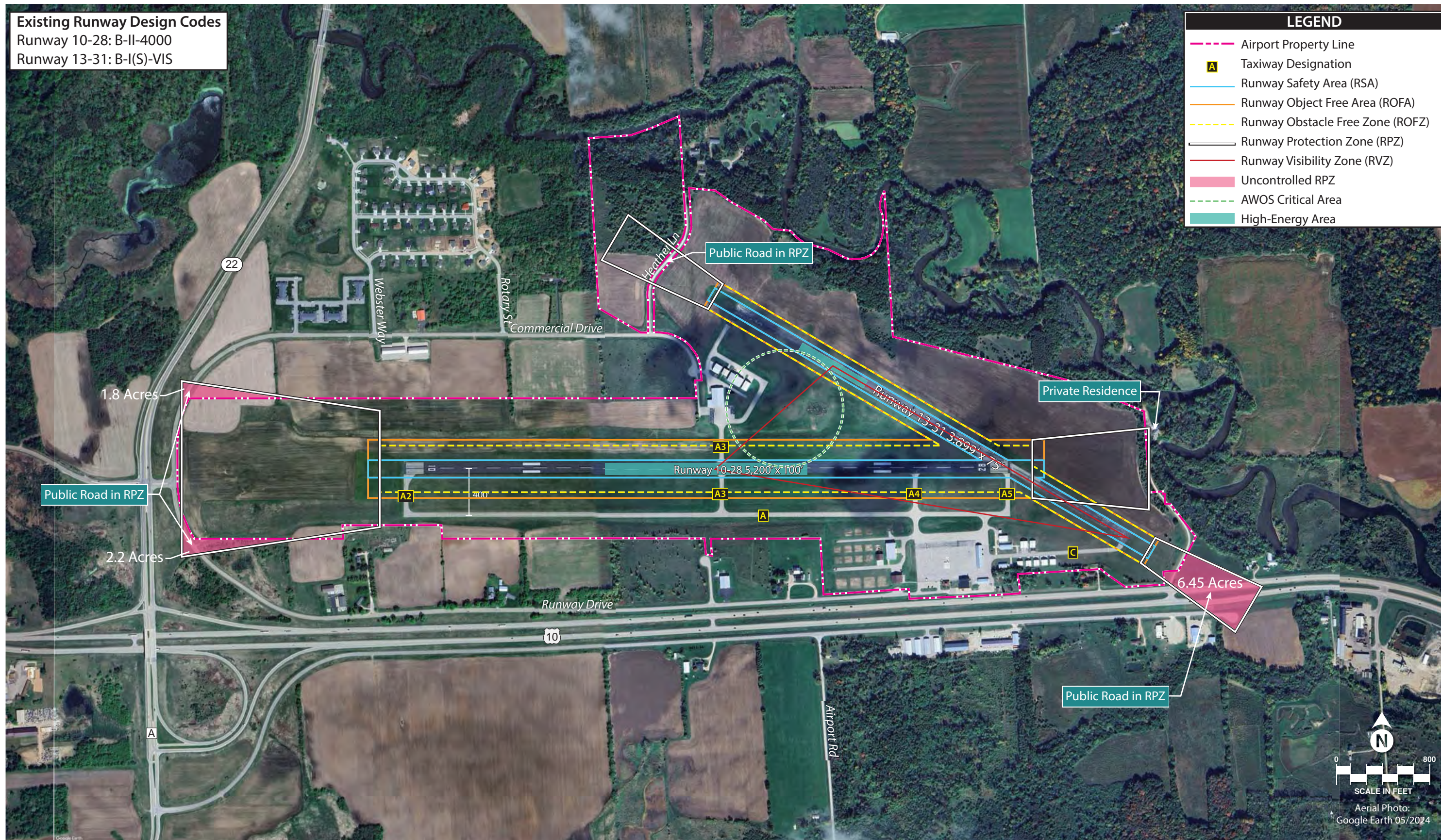
### **Runway Object Free Area**

The ROFA is “a clear area limited to equipment necessary for air and ground navigation and provides wingtip protection in the event of an aircraft excursion from the runway.” It is a two-dimensional ground area surrounding a runway, taxiways, and taxilanes that is clear of objects, except objects with locations that are fixed by function (e.g., airfield lighting). The ROFA does not have to be graded and level like the RSA; instead, the primary requirement for the ROFA is that no object in the ROFA penetrates the lateral elevation of the RSA. The ROFA is centered on the runway, extending out in accordance with the critical aircraft utilizing the runway.

The ROFA design standards associated with primary Runway 10-28 for existing RDC B-II-4000 are 500 feet wide and extend 300 feet beyond the runway end. These dimensions increase to 800 feet wide and extend 1,000 feet beyond the end of the runway in the ultimate C-II-4000 environment. For crosswind Runway 13-31, the ROFA dimensions are 250 feet wide and extend 240 feet beyond the end of the runway in the existing and ultimate conditions. The ROFAs associated with each runway in both the existing and ultimate scenarios are fully contained on airport property, with the exception of a small portion of apron area encompassed within the ultimate Runway 10-28 ROFA on the north side of the runway. Alternative considerations in the next chapter will examine options to fix this condition.

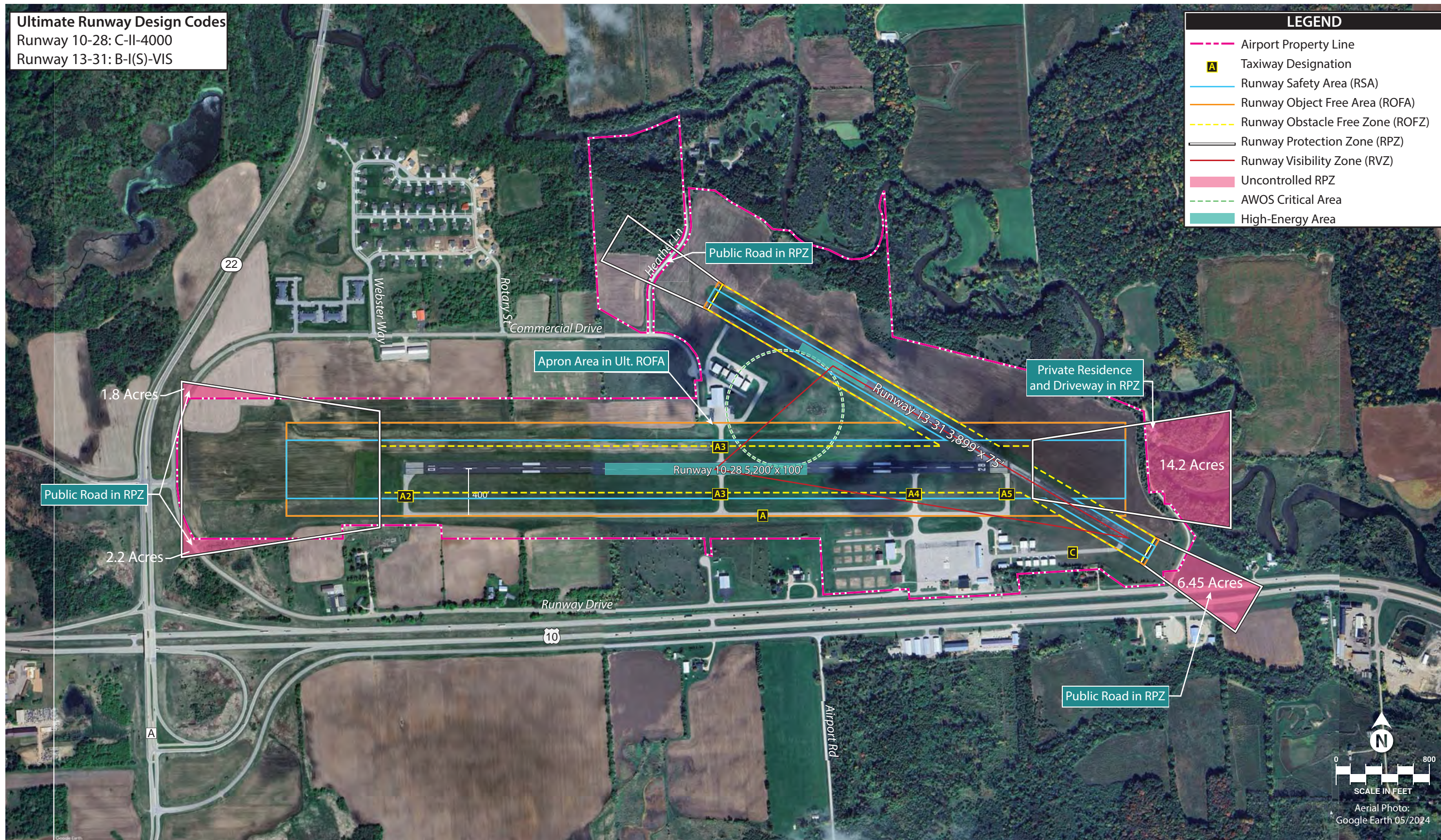
**Existing Runway Design Codes**  
 Runway 10-28: B-II-4000  
 Runway 13-31: B-I(S)-VIS

LEGEND	
	Airport Property Line
	Taxiway Designation
	Runway Safety Area (RSA)
	Runway Object Free Area (ROFA)
	Runway Obstacle Free Zone (ROFZ)
	Runway Protection Zone (RPZ)
	Runway Visibility Zone (RVZ)
	Uncontrolled RPZ
	AWOS Critical Area
	High-Energy Area



**Ultimate Runway Design Codes**  
 Runway 10-28: C-II-4000  
 Runway 13-31: B-I(S)-VIS

LEGEND	
	Airport Property Line
	Taxiway Designation
	Runway Safety Area (RSA)
	Runway Object Free Area (ROFA)
	Runway Obstacle Free Zone (ROFZ)
	Runway Protection Zone (RPZ)
	Runway Visibility Zone (RVZ)
	Uncontrolled RPZ
	AWOS Critical Area
	High-Energy Area





### Obstacle Free Zone

The ROFZ is an imaginary surface that precludes object penetrations, including taxiing and parked aircraft. The only allowance for ROFZ obstructions is navigational aids mounted on frangible bases that are fixed in their locations by function, such as airfield signs. The ROFZ is established to ensure the safety of aircraft operations. If the ROFZ is obstructed, the airport's approaches could be removed, or approach minimums could be increased.

For all runways serving aircraft over 12,500 pounds, the ROFZ is 400 feet wide, centered on the runway, and extends 200 feet beyond the runway ends. This standard applies to primary Runway 10-28 at Waupaca Municipal Airport. For runways serving small aircraft under 12,500 pounds but with approach speeds greater than or equal to 50 knots, the ROFZ is 250 feet wide, centered on the runway, and extends 200 feet beyond the runway ends, which are the dimensions of the ROFZ serving Runway 13-31 under the existing and ultimate condition. Under the current evaluation with available data, there are no ROFZ obstructions at the airport.

### Runway Protection Zone

An RPZ is a trapezoidal area centered on the extended runway centerline beginning 200 feet from the end of the runway. This safety area is established to protect the end of the runway from airspace penetrations and incompatible land uses. The RPZ dimensions are based on the established RDC and the approach visibility minimums serving the runway. While the RPZ is intended to be clear of incompatible objects or land uses, some uses are permitted with conditions and other land uses are prohibited. According to AC 150/5300-13B, Change 1, the following land uses are permissible within the RPZ:

- Farming that meets the minimum buffer requirements;
- Irrigation channels, as long as they do not attract birds;
- Airport service roads, as long as they are not public roads and are directly controlled by the airport operator;
- Underground facilities, as long as they meet other design criteria, such as RSA requirements, as applicable;
- Unstaffed navigational aids (NAVAIDs) and facilities, such as those required for airport facilities that are fixed by function regarding the RPZ; and
- Aboveground fuel tanks associated with backup generators for unstaffed NAVAIDS.

In September 2022, the FAA published AC 150/5190-4B, *Airport Land Use Compatibility Planning*, which states that airport owner control over RPZs is preferred. Airport owner control over RPZs may be achieved through:

- Ownership of the RPZ property in fee simple;
- Possessing sufficient interest in the RPZ property through easements, deed restrictions, etc.;



- Possessing sufficient land use control authority to regulate land use in the jurisdiction that contains the RPZ;
- Possessing and exercising the power of eminent domain over the property; or
- Possessing and exercising permitting authority over proponents of development within the RPZ (e.g., where the sponsor is a state).

AC 150/5190-4B further states that “control is preferably exercised through acquisition of sufficient property interest and includes clearing RPZ areas (and keeping them clear) of objects and activities that would impact the safety of people and property on the ground.” The FAA recognizes that land ownership, environmental, geographical, and other considerations can complicate land use compatibility within RPZs; regardless, airport sponsors must comply with FAA grant assurances, including (but not limited to) Grant Assurance 21, *Compatible Land Use*. Sponsors are expected to take appropriate measures to “protect against, remove, or mitigate land uses that introduce incompatible development within RPZs.” For proposed projects that would shift an RPZ into an area with existing incompatible land uses, such as a runway extension or the construction of a new runway, the sponsor is expected to have or secure sufficient control of the RPZ, ideally through fee simple ownership. Where existing incompatible land uses are present, the FAA expects sponsors to “seek all possible opportunities to eliminate, reduce, or mitigate existing incompatible land uses” through acquisition, land exchanges, right-of-first refusal to purchase, agreement with property owners on land uses, easements, or other such measures. These efforts should be revisited during master plan or ALP updates, and periodically thereafter, and should be documented to demonstrate compliance with FAA grant assurances. If new or proposed incompatible land uses impact an RPZ, the FAA expects the airport to take the above actions to control the property within the RPZ and adopt a strong public stance opposing the incompatible land uses.

For new incompatible land uses that result from a sponsor-proposed action (e.g., an airfield project like a runway extension, a change in the critical aircraft that increases the RPZ dimension, or lower minimums that increase the RPZ dimension), the airport sponsor is expected to conduct an alternatives evaluation. The intent of the alternative’s evaluation is to “proactively identify a full range of alternatives and prepare a sufficient evaluation to be able to draw a conclusion about what is ‘appropriate and reasonable.’” For incompatible development off-airport, the sponsor should coordinate with the Airports District Office (ADO) as soon as the sponsor learns of the development, and the alternatives evaluation should be conducted within 30 days of the sponsor’s first awareness of the development within the RPZ. The following items are typically necessary in an alternative’s evaluation:

- Sponsor’s statement of the purpose and need of the proposed action (airport project, land use change, or development)
- Identification of any other interested parties and proponents
- Identification of any federal, state, and/or local transportation agencies involved
- Analysis of sponsor control of the land within the RPZ
- Summary of all alternatives considered, including:



- Alternatives that preclude introducing the incompatible land use within the RPZ (e.g., zoning action, purchase, and design alternatives, such as implementation of declared distances, displaced thresholds, runway shift or shortening, raising minimums, etc.)
  - Alternatives that minimize the impact of the land use in the RPZ (e.g., rerouting a new roadway through less of the RPZ, etc.)
  - Alternatives that mitigate risk to people and property on the ground (e.g., tunnelling, depressing and/or protecting a roadway through the RPZ, implementing operational measures to mitigate any risks, etc.)
- Narrative discussion and exhibits or figures depicting the alternative
  - Rough order of magnitude cost estimates associated with each alternative, regardless of potential funding sources
  - Practicability assessment based on the feasibility of the alternative in terms of cost, constructability, operational impacts, and other factors

Once the alternatives evaluation has been submitted to the ADO, the FAA will determine whether the sponsor has made an adequate effort to pursue and consider appropriate and reasonable alternatives. **The FAA will not approve or disapprove the airport sponsor's preferred alternative; rather, the FAA will evaluate whether an acceptable level of alternatives analysis has been completed before the sponsor makes the decision to allow or disallow the proposed land use within the RPZ.**

In summary, the RPZ guidance published in September 2022 shifts the responsibility of protecting the RPZ to the airport sponsor. The airport sponsor is expected to take action to control the RPZ or demonstrate that appropriate actions have been taken. The decision to permit or disallow existing or new incompatible land uses within an RPZ is ultimately up to the airport sponsor, with the understanding that the sponsor still has grant assurance obligations, and the FAA retains the authority to review and approve or disapprove portions of the ALP that would adversely impact the safety of people and property within the RPZ.

RPZs have been further designated as approach and departure RPZs. The approach RPZ is a function of the aircraft approach category (AAC) and approach visibility minimums associated with the approach runway end. The departure RPZ is a function of the AAC, and departure procedures associated with the runway. For a particular runway end, the more stringent RPZ requirements (usually associated with the approach RPZ) will govern the property interests and clearing requirements the airport sponsor should pursue.

Under existing conditions, the RPZ serving Runway 10 is 1,000 feet wide at the inner portion, 1,510 feet wide at the outer portion, and 1,700 feet long, while the existing RPZ serving Runway 28 is 500 wide feet at the inner portion, 700 feet wide at the outer portion, and 1,000 feet long. Under ultimate RDC C-II-4000 conditions, the RPZ serving Runway 10 remains the same size, while the RPZ serving Runway 28 increases in size to a dimension of 500 feet wide at the inner portion, 1,010 feet wide at the outer portion, and 1,700 feet long. It should be noted that the size difference for the RPZ serving Runway 10-28



is a result of differing approach minimums serving each runway end; Runway 10 is served by a  $\frac{3}{4}$ -mile instrument approach minimum, while Runway 28 is served by a one-mile instrument approach minimum. The existing and ultimate RPZs serving Runway 13-31 under RDC B-I(S)-VIS are 250 feet at the inner portion, 450 feet at the outer portion, and 1,000 feet long.

As shown on **Exhibit 3B**, for the existing RPZs associated with Runway 10-28 under existing B-II-4000 design conditions, the RPZ serving Runway 10 extends beyond airport property to the west and encompasses approximately 2.2 and 1.8 acres of uncontrolled property (4.0 total acres) in the outer corners of the RPZ, as well as portions of Runway Drive. The existing RPZ serving Runway 28 is contained within airport property; however, a private residence and driveway exist immediately east of airport property and just beyond the Runway 28 RPZ. Under ultimate RDC C-II-4000 conditions, the RPZ serving Runway 28 expands in size, encompassing approximately 14.2 acres of uncontrolled property, as well as the private residence and driveway located immediately east of airport property. Under both the existing and ultimate conditions, the RPZs serving Runway 13-31 are traversed by Heather Lane and Highway 10, respectively. In addition, the RPZ serving Runway 31 extends beyond airport property to the south, encompassing approximately 6.5 acres of uncontrolled property.

Under the ultimate condition, several public roadways pass through the RPZs associated with Runways 10, 13, and 31. Additionally, the RPZ serving Runway 28 extends to the east, encompassing a private residence and driveway; this is considered incompatible land use. Considerations for potential mitigation options will be further explored in the next chapter.

### SEPARATION STANDARDS

Several other standards are related to separation distances from runways and taxiways. Each is designed to enhance the safety of the airfield.

#### Runway/Taxiway Separation

The design standard for the separation between runways and parallel taxiways is a function of the critical aircraft and the instrument approach visibility minimum. The separation standard for primary Runway 10-28 in the existing RDC B-II-4000 condition is 240 feet from the runway centerline to the parallel taxiway centerline. In the ultimate C-II-4000 environment, the separation standard increases to 300 feet. Parallel Taxiway A is currently separated from the runway by 400 feet and should be maintained in its current location. For crosswind Runway 13-31, the runway-to-taxiway separation standard in both the existing and ultimate RDC B-I(S)-VIS conditions is 150 feet. Runway 13-31 is not currently served by a parallel taxiway. It should be noted that there is a taxilane serving the north hangars that is parallel to Runway 13-31 and is separated by approximately 430 feet from the runway centerline.

#### Hold Line Position Separation

Hold line position markings are placed on taxiways leading to runways. When instructed, pilots are to stop short of the holding position marking line. The existing and ultimate design standards for Runway 10-28 call for holding positions to be separated from the runway centerline by 200 feet (existing) and 250 feet (ultimate). The existing and ultimate design standards for Runway 13-31 call for holding positions to be separated from the runway centerline by 125 feet.



At Waupaca Municipal Airport, each hold line position marking serving primary Runway 10-28 is situated 250 feet from the runway centerline and should be maintained. The holding positions serving Runway 13-31 are situated at 125 and 170 feet from the runway centerline, respectively, and meet existing and ultimate B-I(S) design standards; however, it should be noted that Taxiway C is acutely angled to the runway as it connects to the Runway 31 threshold, which means the hold position is not angled at 90 degrees to Runway 13-31. The alternatives in the next chapter will consider options to orient all hold positions at 90 degrees perpendicular to their respective runways.

### Aircraft Parking Area Separation

According to FAA AC 150/5300-13B, Change 1, aircraft parking positions should be located to ensure that aircraft components (wings, tail, and fuselage) do not:

1. Conflict with the object free area for the adjacent runway or taxiways:
  - a. Runway object free area (ROFA)
  - b. Taxiway object free area (TOFA)
  - c. Taxilane object free area (TLOFA)

Or

2. Violate any of the following aeronautical surfaces and areas:
  - a. Runway approach or departure surface
  - b. Runway visibility zone (RVZ)
  - c. Runway obstacle free zone (ROFZ)
  - d. Navigational aid equipment critical areas

Existing aircraft parking positions at Waupaca Municipal Airport are located on each aircraft parking apron. In their existing locations, each marked aircraft parking position at PCZ is clear of the safety areas, as well as the aeronautical surfaces and areas detailed above. In the ultimate condition, a portion of the northern apron is in the C-II ROFA, which needs to be kept clear. The alternatives analysis in the next chapter will examine potential solutions to this issue.

### TAXIWAYS

The design standards associated with taxiways are determined by the taxiway design group (TDG) or the ADG of the airport's critical aircraft. As determined previously, the applicable ADG for primary Runway 10-28 is ADG II in the existing and ultimate conditions, while the ADG for Runway 13-31 has been identified as ADG I in the existing and ultimate conditions. **Table 3G** presents the various taxiway design standards related to both ADG I and II. The table also shows the taxiway design standards related to TDG. The TDG standards are based on the main gear width (MGW) and cockpit to main gear (CMG) distance of the critical aircraft expected to use those taxiways. Different taxiway and taxilane pavements can and should be planned to the most appropriate TDG design standards, based on usage.



The current design for all taxiways at PCZ is TDG 2A, which dictates a width of 35 feet. Taxiway A and its associated connectors are currently 40 feet wide, while Taxiway C is 35 feet wide. While the 40-foot width provides an added safety margin for aircraft operating at the airport, the BOA may elect not to fund regular pavement maintenance for the portions of taxiway pavement that exceed the standard. If the airport chooses to maintain the taxiways at their current widths, the costs may need to come from a local funding source, rather than federal or state grant monies. Certain portions of the landside area that are utilized exclusively by small aircraft should adhere to TDG 1A/1B standards.

**TABLE 3G | Taxiway Dimensions and Standards**

STANDARDS BASED ON WINGSPAN	ADG I	ADG II
<b>Taxiway and Taxilane Protection</b>		
Taxiway Safety Area Width (TSA)	49'	79'
Taxiway Object Free Area Width (TOFA)	89'	124'
Taxilane Object Free Area Width (TLOFA)	79'	110'
<b>Taxiway and Taxilane Separation</b>		
Taxiway Centerline to Parallel Taxiway Centerline	70'	101.5'
Taxiway Centerline to Fixed or Moveable Object	44.5'	62'
Taxilane Centerline to Parallel Taxilane Centerline	64'	94.5'
Taxilane Centerline to Fixed or Moveable Object	39.5'	55'
<b>Wingtip Clearance</b>		
Taxiway Wingtip Clearance	20'	22.5'
Taxilane Wingtip Clearance	15'	15.5'
<b>STANDARDS BASED ON TDG</b>		
	<b>TDG 1A/B</b>	<b>TDG 2A/B</b>
Taxiway Width Standard	25'	35'
Taxiway Edge Safety Margin	5'	7.5'
Taxiway Shoulder Width	10'	15'
Note: All dimensions are in feet. ADG = airplane design group TDG = taxiway design group		

Source: FAA AC 150/5300-13B, Airport Design, Change 1

Exhibit 3C shows the TOFA for Taxiway A, which is 124 feet wide and clear of obstructions, and should be maintained as such.



Exhibit 3C – Taxiway A TOFA



### Taxiway and Taxilane Design Considerations

FAA AC 150/5300-13B, *Airport Design*, Change 1, provides guidance on recommended taxiway and taxilane layouts to enhance safety by avoiding runway incursions. A runway incursion is defined as “any occurrence at an airport involving the incorrect presence of an aircraft, vehicle, or person on the protected area of a surface designated for the landing and takeoff of aircraft.” The following is a list of the FAA’s taxiway design guidelines and the basic rationale behind each recommendation included in the current AC, as well as previous FAA safety and design recommendations.

1. **Taxiing Method:** Taxiways are designed for cockpit-over-centerline taxiing with pavement that is wide enough to allow a certain amount of wander. On turns, sufficient pavement should be provided to maintain the edge safety margin from the landing gear. When constructing new taxiways, existing intersections should be upgraded to eliminate judgmental oversteering, which is when a pilot must intentionally steer the cockpit outside the marked centerline to ensure the aircraft remains on the taxiway pavement.
2. **Curve Design:** Taxiways should be designed so the nose gear steering angle is no more than 50 degrees, which is the generally accepted value to prevent excessive tire scrubbing.
3. **Three-Path Concept:** To maintain pilot situational awareness, taxiway intersections should provide a pilot with a maximum of three choices of travel. Ideally, these are right, left, and a continuation straight ahead.
4. **Channelized Taxiing:** To support visibility of airfield signage, taxiway intersections should be designed to meet standard taxiway width and fillet geometry.
5. **Designated Hot Spots and Runway Incursion Mitigation (RIM) Locations:** A hot spot is a location on the airfield with elevated risk of collisions or runway incursions. Mitigation measures should be prioritized for areas the FAA designates as hot spots or RIM locations.
6. **Intersection Angles:** Design turns to be 90 degrees, wherever possible. For acute-angle intersections, standard angles of 30, 45, 60, 120, 135, and 150 degrees are preferred.
7. **Runway Incursions:** Design taxiways to reduce the probability of runway incursions.
  - *Increase Pilot Situational Awareness:* A pilot who knows where he/she is on the airport is less likely to enter a runway improperly. Complexity leads to confusion. Keep taxiway systems simple by using the three-path concept.
  - *Avoid Wide Expanses of Pavement:* Wide pavements require placement of signs far from a pilot’s eye. This is especially critical at runway entrance points. Where a wide expanse of pavement is necessary, avoid direct access to a runway.
  - *Limit Runway Crossings:* The taxiway layout can reduce the opportunity for human error. The benefits are twofold: through a simple reduction in the number of occurrences and a reduction in air traffic controller workload.



- *Avoid High-Energy Intersections:* These are intersections in the middle thirds of runways. By limiting runway crossings to the first and last thirds of a runway, the portion of the runway where a pilot can least maneuver to avoid a collision is kept clear.
- *Increase Visibility:* Right-angle intersections between both taxiways and runways provide the best visibility. Acute-angle runway exits provide greater efficiency in runway usage but should not be used as runway entrance or crossing points. A right-angle turn at the end of a parallel taxiway is a clear indication of approaching a runway.
- *Avoid Dual-Purpose Pavements:* Runways used as taxiways and taxiways used as runways can lead to confusion. A runway should always be clearly identified as a runway, and only a runway.
- *Direct Access:* Do not design taxiways to lead directly from an apron to a runway. Such configurations can lead to confusion when a pilot typically expects to encounter a parallel taxiway.
- *Hot Spots:* Confusing intersections near runways are more likely to contribute to runway incursions. These intersections must be redesigned when the associated runway is subject to reconstruction or rehabilitation. Other hot spots should be corrected as soon as practicable.

### 8. Runway/Taxiway Intersections

- *Right Angle:* Right-angle intersections are the standard for all runway/taxiway intersections, except where there is a need for an acute-angled exit. Right-angle taxiways provide the best visual perspective to a pilot approaching an intersection with the runway to observe aircraft in both the left and right directions. They also provide optimal orientation of the runway holding position signs, so the signage is visible to pilots.
- *Acute Angle:* Acute angles should not be larger than 45 degrees from the runway centerline. A 30-degree taxiway layout should be reserved for high-speed exits. The use of multiple intersecting taxiways with acute angles creates pilot confusion and improper positioning of taxiway signage. The construction of high-speed exits is typically only justified for runways with regular use by jet aircraft in approach categories C and above.
- *Large Expanses of Pavement:* A taxiway must never coincide with the intersection of two runways. Taxiway configurations with multiple taxiway and runway intersections in a single area create large expanses of pavement, which make it difficult to provide proper signage, marking, and lighting.

9. **Taxiway/Runway/Apron Incursion Prevention:** Apron locations that allow direct access into a runway should be avoided. Increase pilot situational awareness by designing taxiways in a manner that forces pilots to consciously make turns. Taxiways that originate from aprons and form straight lines across runways at mid-span should be avoided.



- *Wide Throat Taxiways:* Wide throat taxiway entrances should be avoided. Such large expanses of pavement may cause pilot confusion and make lighting and marking more difficult.
- *Direct Access from Apron to a Runway:* Avoid taxiway connectors that cross over a parallel taxiway and directly onto a runway. Consider a staggered taxiway layout or a no-taxi island that forces pilots to make a conscious decision to turn.
- *Apron to Parallel Taxiway End:* Avoid direct connection from an apron to a parallel taxiway at the end of a runway.

The taxiway system at Waupaca Municipal Airport generally provides for the efficient movement of aircraft, and there are no FAA-designated hot spots at the airport; however, there is direct access from both aprons at the airport, as shown on **Exhibit 3D**. It should be noted that there are geometry issues, including the acute-angle Taxiway C connection to Runway 31, direct access provided by Taxiways A3 and A4, and Taxiway A3 crossing through the high-energy area (the middle third) of Runway 10-28. Potential solutions to correct these issues will be examined in the alternatives chapter. Analysis in the next chapter will also consider improvements that could be implemented on the airfield to minimize runway incursion potential, improve efficiency, and conform to FAA standards for taxiway design.



*Exhibit 3D – Non-Standard Taxiway Geometry*

### Taxilane Design Considerations

Taxilanes are distinguished from taxiways in that they do not provide direct access to or from the runway system. Taxilanes typically provide access to hangar areas and can be planned to varying design standards, depending on the type(s) of aircraft that utilize the taxilane, as described previously.



### NAVIGATIONAL AND APPROACH AIDS

Navigational aids are devices that provide pilots with guidance and position information when utilizing the runway system. Electronic and visual guidance to arriving aircraft enhance the safety and capacity of the airfield. Such facilities are vital to the success of an airport and provide additional safety to pilots and passengers using the air transportation system. While instrument approach aids are especially helpful during poor weather, they are often used by pilots conducting flight training and operating larger aircraft when visibility is good.

#### Instrument Approach Aids

Waupaca Municipal Airport has two published instrument approaches. A localizer performance with vertical guidance (LPV) via an area navigation (RNAV) GPS instrument approach is available to each end of Runway 10-28. The Runway 10 approach has visibility minimums down to  $\frac{3}{4}$ -mile for categories A, B, C, and D aircraft, while Runway 28 has a one-mile approach.

Crosswind Runway 13-31 is currently a visual runway with no published instrument approach procedures and is planned to remain as such in the ultimate condition; however, for planning purposes, the alternatives will consider the possible implementation of an instrument approach procedure with visibility minimums not lower than one-mile if there is local interest. This would not alter the size of the existing RPZs associated with Runway 13-31, but any costs associated with an ultimate approach will likely be ineligible for funding assistance due to the current crosswind coverage of Runway 10-28.

#### Visual Approach Aids

In most instances, the landing phase of any flight must be conducted in visual conditions. Electronic visual approach aids are commonly used at airports to provide pilots with visual guidance information during landings on the runway. Both ends of primary Runway 10-28 are currently equipped with a two-box precision approach path indicator (PAPI-2) system. As more turbine aircraft begin to operate at the airport, consideration should be given to upgrading the PAPI-2 to a PAPI-4 (four-box system) on each runway end.

Runway end identification lights (REILs) are flashing lights located at the runway threshold end that facilitate rapid identification of the runway end at night and during poor visibility conditions. REILs provide pilots with the ability to identify the runway thresholds and distinguish the runway end lighting from the other lighting on the airport and in the approach areas. The FAA indicates that REILs should be considered for all lighted runway ends not planned for more sophisticated approach lighting systems. Both ends of primary Runway 10-28 are equipped with REILs, which should be maintained.

Crosswind Runway 13-31 is equipped with differing PAPI systems. Runway 13 is served by a PAPI-4 (four-box system) while Runway 31 is equipped with a PAPI-2. Runway 13-31 is not currently served by REILs. Pending the future disposition of Runway 13-31, consideration should be given to maintaining the current PAPI systems and installing REILs at each runway end.



### Weather Reporting Aids

Waupaca Municipal Airport has a lighted wind cone and wind tee, which are centrally located between the two runways. These provide information to pilots regarding wind speed and direction and should be maintained through the planning period. A segmented circle is often co-located with an airport's primary wind cone. The segmented circle is a system of visual indicators designed to provide traffic pattern information to pilots.

The airport is also equipped with an automated weather observation station (AWOS), which provides weather observations 24 hours per day. The system updates weather observations every minute, continuously reporting significant weather changes as they occur in real time. This information is transmitted via a designated radio frequency at regular intervals. FAA siting criteria indicate that the AWOS should be located between 1,000 and 3,000 feet from the runway threshold and between 500 to 1,000 feet perpendicular to the runway centerline. The AWOS also has a 500-foot radius critical area that must be kept free of obstructions that could interfere with its sensors. The AWOS at Waupaca Municipal Airport should be maintained in its current location through the planning period.

### AIRFIELD LIGHTING, MARKING, AND SIGNAGE

Several lighting and pavement marking aids serve pilots using the airport. These aids assist pilots in locating the airport and runway at night or in poor visibility conditions. They also serve aircraft navigating the airport environment on the ground when transitioning to/from aircraft parking areas to the runway.

**Airport Identification Lighting** | Waupaca Municipal Airport's rotating beacon is located on the south side of the airport property by the entrance to the public parking area. The beacon should be maintained during the planning period.

**Runway and Taxiway Lighting** | Both runways are equipped with a medium intensity runway lighting (MIRL) system, which is adequate and should be maintained. It should be noted that only taxiway entrances are lighted. Planning should consider the implementation of medium intensity taxiway lighting (MITL) on all taxiways and the expansion of both MIRL and MITL systems if/when new pavements are constructed.

**Airfield Signs** | Airfield identification signs assist pilots in identifying their locations on the airfield and directing them to their desired locations. Lighted signs are installed on the runway and taxiway systems on the airfield. The signage system includes lighted runway and taxiway designations and routing/directional signage. All signs should be maintained through the planning period.

It should be noted that many airports are transitioning to light-emitting diode (LED) systems. LEDs have many advantages, including lower energy consumption, longer lifespan, increased durability, reduced size, greater reliability, and faster switching. While a larger initial investment is required up front, the energy savings and reduced maintenance costs outweigh any additional costs over time.

**Pavement Markings** | Runway markings are typically designed to the type of instrument approach available on the runway. FAA AC 150/5340-1K, *Standards for Airport Markings*, provides guidance



necessary to design airport markings. Runways 10-28 and 13-31 are both equipped with non-precision markings. These runway markings should be maintained through the long-term planning horizon on Runway 10-28. Pending the future disposition of Runway 13-31, the current non-precision markings could be maintained if a GPS approach is considered. If Runway 13-31 is maintained as a visual runway, it could be marked with basic markings.

A summary of the airside facilities at Waupaca Municipal Airport is presented on **Exhibit 3E**.

### **LANDSIDE FACILITY REQUIREMENTS**

Landside facilities are those necessary for the handling of aircraft and passengers while on the ground. These facilities provide the essential interface between the air and ground transportation modes. The capacity of the various components of each element was examined in relation to projected demand to identify future landside facility needs. For Waupaca Municipal Airport, this includes components for general aviation needs, such as the following:

- General aviation terminal facilities and auto parking
- Aircraft storage hangars
- Aircraft parking aprons
- Airport support facilities

Projections made for aircraft storage hangars, aircraft parking aprons, and marked parking positions are based on the number of aircraft currently based and forecast to base on the airport property over the 20-year planning horizon. Terminal facilities, auto parking, and other airport support facilities are based on the annual number of operations projected to occur over the planning period.

In addition to landside facility requirements, potential non-aeronautical land uses will be evaluated in subsequent chapters. These are portions of airport property that are suitable for non-aviation purposes and can generate revenue for the airport, such as agriculture or industrial uses. While airport property is generally subject to Airport Improvement Program (AIP) grant assurances, an airport can request a release from aeronautical federal obligations for certain areas of property that are not necessary for aviation uses. These requests are facilitated under the *FAA Reauthorization Act of 2018*, Section 163, which governs the FAA's authority over non-aeronautical development.

### **GENERAL AVIATION TERMINAL SERVICES**

The general aviation terminal facilities at an airport often provide corporate officials and visitors with their first impressions of the community. General aviation terminal facilities at an airport can provide space for passenger waiting, a pilots' lounge, flight planning, concessions, management, storage, and many other various needs. This space is not necessarily limited to a single, separate terminal building, but can include space offered by fixed base operators (FBOs) and other specialty operators for these functions and services. At Waupaca Municipal Airport, general aviation terminal services are provided in the terminal building, which includes a lobby, a pilots' lounge, a conference room, a kitchen, and restrooms.



	EXISTING	ULTIMATE	EXISTING	ULTIMATE
	10-28	10-28	13-31	13-31*
<b>Runways</b>				
Runway Design Code (RDC)	B-II-4000	C-II-4000	B-I(S)-VIS	B-I(S)-VIS
Dimensions	5,200' x 100'	Consider extension; maintain width	3,899' x 75'	Maintain
Pavement Strength	30,000 lbs (S)	Maintain/Consider 60,000 lbs (D)	13,000 lbs S	Maintain
<b>Safety Areas</b>				
RSA	Standard RSA	Maintain	Standard RSA	Maintain
ROFA	Standard ROFA	Maintain	Standard ROFA	Maintain
ROFZ	Standard ROFZ	Maintain	Standard ROFZ	Maintain
RPZ	Extend beyond airport property; include roadways	Consider mitigation	Extend beyond airport property; include roadways	Consider mitigation
<b>Taxiways</b>				
Design Group	2A	Maintain	1A	Maintain
Parallel Taxiway	Taxiway A (parallel)	Maintain	NA	Maintain
Parallel Taxiway Separation from Runway	400'	Maintain	NA	Maintain
Widths	40' (Taxiway A and connectors)	Maintain	35' (Taxiway C and connectors)	Maintain if feasible
Holding Position Separation	250'	Maintain	125', 170'	Consider geometry upgrades
Notable Conditions	None	Maintain	Numerous cracks and vegetation in pavement	Consider corrective measures
<b>Navigational and Weather Aids</b>				
Instrument Approaches	LPV GPS (10, 28)	Maintain	Visual only	Maintain
Weather Aids	AWOS, wind cones, rotating beacon, segmented circle	Maintain equipment		
Approach Aids	PAPI-2 & REILS on both runway ends maintain REILs	Consider upgrade to PAPI-4;	PAPI-2 / PAPI-4 and REILs	Maintain/Consider REILs
<b>Lighting and Marking</b>				
Runway Lighting	MIRL	Maintain	MIRL	Maintain
Runway Marking	Non-precision	Maintain	Published as NPI	Consider Basic
Taxiway Lighting	MITL (Taxiway A) Entrance Only	Consider MITL along Taxiway A	No lighting on Taxiway C	Install MITL on Taxiway C

\*Pending Ultimate Disposition of Runway 13-31 Due to Lack of Funding Eligibility.



<b>KEY</b>	AWOS - Automated Weather Observing System	RDC - Runway Design Code	RSA - Runway Safety Area
	MIRL - Medium Intensity Runway Lighting	REIL - Runway End Identification Lights	S - Single Wheel
	MITL - Medium Intensity Taxiway Lighting	ROFA - Runway Object Free Area	TDG - Taxiway Design Group
	NPI - Non-Precision Instrument	ROFZ - Runway Obstacle Free Zone	
	PAPI - Precision Approach Path Indicator	RPZ - Runway Protection Zone	

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The methodology used in estimating general aviation terminal facility needs was based on the number of airport users expected to utilize general aviation facilities during the design hour. This methodology is a general airport planning practice and is not considered exacting, as each airport terminal serves unique functions. The space requirements for terminal building facilities were based on providing 125 square feet (sf) per design hour itinerant passenger. A multiplier of 2.0 in the short term, increasing to 3.0 in the long term, was also applied to terminal facility needs to better determine the number of passengers associated with each itinerant aircraft operation. This increasing multiplier indicates an expected increase in larger aircraft operations through the long term. These operations typically support larger turboprop and jet aircraft, which can accommodate an increasing passenger load factor. Such is the case at Waupaca Municipal Airport, where an increasing number of turbine operations are anticipated.

**Table 3H** outlines the space requirements for general aviation terminal services at Waupaca Municipal Airport through the long-term planning period. The amount of space currently offered in the terminal building is approximately 2,600 sf. As shown in the table, additional terminal space is needed over the long-term planning period.

**TABLE 3H | General Aviation Terminal Area Facilities**

	Currently Available	Short-Term Need	Intermediate-Term Need	Long-Term Need
Terminal Building (sf)	2,600	2,400	3,100	4,100
General Aviation Design Hour Passengers	–	10	10	11
Passenger Multiplier	–	2.0	2.5	3.0
Visitor/Tenant Vehicle Parking	35	35	42	53

*Source: Coffman Associates analysis*

General aviation vehicle parking demands have also been determined for the airport. Space determinations for passengers were based on an evaluation of existing airport use, as well as standards set forth to help calculate projected terminal facility needs. There are currently 35 marked individual vehicle spaces provided at the airport. Most based aircraft owners park near their hangars. As shown in the table, additional vehicle parking could be needed over the planned period. In the next chapter, proposed hangar facility layouts will include dedicated vehicle parking for tenants.

**AIRCRAFT HANGARS**

Utilization of hangar space varies as a function of local climate, security, and owner preference. The trend in general aviation aircraft is toward more sophisticated (and consequently, more expensive) aircraft; therefore, many aircraft owners prefer enclosed hangar space, as opposed to outside tiedowns.

The demand for aircraft storage hangars is dependent on the number and type(s) of aircraft expected to be based at the airport in the future. For planning purposes, it is necessary to estimate hangar requirements based on forecast operational activity; however, hangar development should be based on actual demand trends and financial investment conditions.

While most aircraft owners prefer enclosed aircraft storage, some will still use outdoor tiedown spaces, usually due to lack of available hangar space, high hangar rental rates, or operational needs; therefore, enclosed hangar facilities do not necessarily need to be planned for each based aircraft.



Hangar types vary greatly in size and function. T-hangars, box hangars, and shade hangars are popular with aircraft owners who need to store individual private aircraft. These hangars often provide individual spaces within a larger structure or in standalone portable buildings. There is approximately 112,500 sf of total hangar storage space at the airport. For determining future aircraft storage needs, a planning standard of 1,200 sf per aircraft is utilized for this type of hangar.

Executive box hangars are open-space facilities with no interior supporting structures. These hangars can vary in size from 1,500 and 2,500 sf to nearly 10,000 sf. They are typically able to house single-engine, multi-engine, turboprop, and jet aircraft, as well as helicopters. For future planning, standards of 3,000 sf per turboprop, 5,000 sf per jet, and 1,500 sf per helicopter are utilized for executive box hangars. There is approximately 71,200 sf of space for executive box hangars at PCZ.

Conventional hangars are large open-space facilities with no supporting interior structures. These hangars provide for bulk aircraft storage and are often utilized by airport businesses, such as FBOs or aircraft maintenance operators. Conventional hangars are generally larger than executive box hangars and can range in size from 10,000 sf to more than 20,000 sf. Portions of conventional hangars are often utilized for non-aircraft storage needs, such as maintenance or office space. There are two conventional hangars at Waupaca Municipal Airport, which total 28,400 sf. For planning purposes, the same aircraft sizing standards utilized for executive hangars are also utilized for conventional hangars.

Requirements for maintenance/service hangar area have also been calculated. There is one maintenance/service provider at the airport, which operates out of an executive hangar that is approximately 12,000 sf in size. To determine service hangar needs, a planning standard of 125 sf per based aircraft has been calculated and was found to be 8,300 sf over the long-term planning period.

Future hangar requirements for the airport are summarized in **Table 3J**. While most based aircraft owners prefer enclosed hangar space, it is assumed that some will use tiedowns on the apron. The analysis shows that future hangar requirements indicate a potential need for over 55,000 sf of new hangar storage capacity throughout the long-term planning period. This includes a mixture of hangar types, with the largest need projected in the executive/conventional hangar category. Due to the projected increase in based aircraft, the existing demand for hangar space, annual general aviation operations, and hangar storage needs, facility planning will consider additional hangars at the airport. It is expected that the aircraft storage hangar requirements will continue to be met through a combination of hangar types.

TABLE 3J | Aircraft Hangar Requirements

	Currently Available	Short-Term Need	Intermediate-Term Need	Long-Term Need	Difference
Total Based Aircraft	49	53	57	66	+17
<b>Hangar Area Requirements</b>					
T-Hangar Area (sf)	9,800	24,200	26,500	39,100	+29,300
Executive Box/Conventional Hangar Area (sf)	88,100	94,100	108,400	117,900	+29,800
Service Hangar Area (sf)	12,000	6,600	7,100	8,300	+2,400
<b>Total Hangar Area (sf)</b>	<b>109,900</b>	<b>124,900</b>	<b>142,000</b>	<b>165,300</b>	<b>+55,400</b>

Source: Coffman Associates analysis



It should be noted that hangar requirements are general in nature and are based on aviation demand forecasts. The actual need for hangar space will further depend on the usage within the hangars. For example, some hangars may be utilized entirely for non-aircraft storage, such as maintenance, but they have an aircraft storage capacity from a planning standpoint; therefore, the needs of an individual user may differ from the calculated space necessary.

AIRCRAFT PARKING APRONS

The aircraft parking apron is an expanse of paved area intended for aircraft parking and circulation. Typically, a main apron is centrally located near the airside entry point, such as the terminal building or FBO facility. Ideally, the main apron is large enough to accommodate transient airport users, as well as a portion of locally based aircraft. Smaller aprons are often available adjacent to FBO or specialty aviation service operator (SASO) hangars and at other locations around the airport. The apron layout at Waupaca Municipal Airport generally follows this pattern, with an apron adjacent to both the terminal and the FBO facility (KlattAero). A second apron, located on the north side of the airport by Red Door Hangar, provides additional dedicated aircraft parking space.

To determine future apron needs, the FAA-recommended planning criterion<sup>2</sup> of 800 square yards (sy) was used for single- and multi-engine itinerant aircraft, while a planning criterion of 1,600 sy was used to determine the area for transient turboprop and jet aircraft. A parking apron should also provide space for locally based aircraft that require temporary tiedown storage. Locally based tiedowns are typically utilized by smaller single-engine aircraft; thus, a planning standard of 650 sy per position is utilized.

The total apron parking requirements are presented in Table 3K. The existing apron pavement area at Waupaca Municipal Airport encompasses approximately 16,700 sy of space, divided between the two apron areas. Approximately 16,700 sy of this space is used exclusively for aircraft parking. Using the planning standards described above and factoring in assumptions regarding operational and based aircraft growth, additional apron space is projected to be needed; an additional 9,900 sy of aircraft parking apron pavement is estimated to be needed over the next 20 years.

Currently, 29 marked parking positions are available for based and itinerant aircraft at the airport. There is no helicopter parking. As shown in the table, additional aircraft parking is projected to be needed, beginning in the short term, including dedicated parking for helicopters and small corporate jets.

TABLE 3K | Aircraft Parking Apron Requirements

	Available	Short Term	Intermediate Term	Long Term
<b>Aircraft Parking Positions</b>				
Based/Local GA Aircraft	–	3	3	3
Transient GA Aircraft	–	20	21	23
Corporate Jet Aircraft	–	1	2	3
Helicopter	–	1	1	2
Total Parking Positions	29	25	27	31
<b>Total Apron Area</b>	<b>16,700</b>	<b>20,000</b>	<b>22,500</b>	<b>26,600</b>

Source: Coffman Associates analysis

<sup>2</sup> Refer to Advisory Circular (AC) 150/5300-13B, Airport Design, Change 1, Appendix E



### SUPPORT FACILITIES

Various other landside facilities that play a supporting role in overall airport operations have also been identified. These support facilities include the following:

- Aviation fuel storage
- Perimeter fencing and gates

#### Aviation Fuel Storage

The airport's fuel storage tanks are located on the terminal apron. There is one 12,000-gallon tank for 100LL Avgas fuel and one 12,000-gallon tank for Jet A fuel. Generally, a fuel tank should be of adequate capacity to accept a full refueling tanker (approximately 8,000 gallons) while maintaining a reasonable level of fuel in the storage tank. Future aircraft demand experienced by the airport will determine the need for additional fuel storage capacity. It is important that airport personnel work with the fuel service provider and other specialty aviation operators to plan for adequate fuel storage capacity through the long-term planning period. Because the current fuel storage capacity can accommodate a full refueling tanker, it is recommended that the airport maintain the fuel storage capacity for 100LL and Jet A fuels at 12,000 gallons each. This allows the fuel service provider to maintain a reasonable level of fuel for customers while accepting a full refueling tanker load of fuel, which would ultimately prevent the need to completely drain a fuel tank prior to receiving another load of fuel.

#### Maintenance and Snow Removal Equipment (SRE) Facility

Maintenance equipment at PCZ includes a New Holland TV6070 tractor that is used for mowing and some snow removal. The airport also has a New Holland T8 tractor, which is used for snow removal and was acquired in 2022, and a 2023 Hustler zero-turn lawn mower that is used for mowing. Other snow implements include a tractor-mounted plow, blower, broom, and sprayer, and a runway deicing fluid foundry is provided. A truck-mounted salt spreader is also available. Alternatives presented in the next chapter will consider a dedicated airport maintenance and SRE facility.

#### Perimeter Fencing and Gates

Perimeter fencing is used at airports primarily to secure the aircraft operational area. The physical barrier of perimeter fencing:

- Gives notice of the legal boundary of the outermost limits of the facility or security-sensitive areas;
- Assists in controlling and screening authorized entries into a secured area by deterring entry elsewhere along the boundary;
- Supports surveillance, detection, assessment, and other security functions by providing a zone for installing intrusion detection equipment and closed-circuit television (CCTV);
- Deters casual intruders from penetrating the aircraft operations areas on the airport;



- Creates a psychological deterrent;
- Demonstrates a corporate concern for facilities; and
- Limits inadvertent access to the aircraft operations area by wildlife.

Waupaca Municipal Airport has limited fencing. A roll-open gate near the terminal allows access to the airport. There is a coded gate to the hangars for pilots, and the doors to the terminal building are also coded for after-hours use. All fencing, gates, and coded doors should be maintained through the planning period and should be regularly inspected to ensure they are functioning properly and are undamaged. Long-term planning will consider the implementation of a perimeter fence that fully surrounds the airport.

A summary of the overall general aviation landside facilities is presented on **Exhibit 3F**.

### ***SUMMARY***

This chapter has outlined the safety design standards and facilities required to meet the potential aviation demand projected at Waupaca Municipal Airport for the next 20 years. To provide a more flexible master plan, the yearly forecasts from Chapter Two have been converted to planning horizon levels. The short term roughly corresponds to a five-year time period, the intermediate term is approximately 10 years, and the long term is 20 years. By utilizing planning horizons, airport management can focus on demand indicators for initiating projects and grant requests, rather than on specific dates in the future.

In Chapter Four, potential improvements to the airside and landside systems will be examined through a series of airport development alternatives. Most of the alternatives discussion will focus on those capital improvements that would be eligible for federal and state grant funds. Other projects of local concern will also be presented. Ultimately, an overall airport development plan that presents a vision beyond the 20-year scope of this master plan will be developed for Waupaca Municipal Airport.



Available | Short Term | Intermediate Term | Long Term

### Aircraft Storage Hangars



Aircraft to be Hangared	43	46	48	54
T-Hangar Area (sf)	9,800	24,200	26,500	39,100
Executive/Conventional Hangar Area (sf)	88,100	94,100	108,400	117,900
Service/Maintenance Area (sf)	12,000	6,600	7,100	8,300
<b>Total Hangar Storage Area (sf)</b>	<b>109,900</b>	<b>124,900</b>	<b>142,000</b>	<b>165,300</b>

### Aircraft Parking Apron



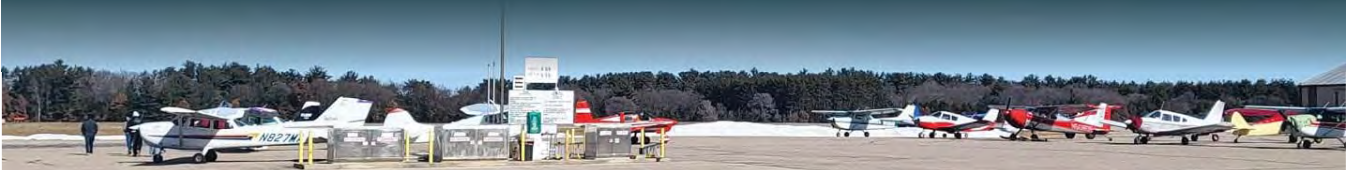
Aircraft Parking Positions	18	24	27	32
Total Public Apron Area (sy)	16,700	20,000	22,500	26,600

### General Aviation Terminal Facilities and Parking



Terminal Building Space (sf)	2,600	2,400	3,100	4,100
Total GA Parking Spaces	35	35	42	18

### Fuel Storage Requirements



	Available		Short Term	Intermediate Term	Long Term
	Capacity	# of tanks			
Jet A	12,000	1		Maintain	
AvGas	12,000	1		Maintain	